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THE

AËRONAUTICAL JOURNAL

A QUARTERLY ILLUSTRATED MAGAZINE DEVOTED TO ALL SUBJECTS CONNECTED WITH THE NAVIGATION OF THE AIR

EDITED FOR THE COUNCIL OF THE AËRONAUTICAL SOCIETY OF GREAT BRITAIN

BY

COLONEL J. D. FULLERTON, R.E. (*Ret.*), F.R.G.S., F.Z.S.

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53, Victoria Street, Westminster, London, S.W.

NOTICES OF The Aëronautical Society of Great Britain.

At a Council Meeting of the Aëronautical Society of Great Britain, held at 53, Victoria Street, Westminster, on Monday, November 9th, 1908.

1. The undermentioned gentlemen were elected members of the Society:

	Date.
Mr. O. M. Shepherd ...	16 July, 1908
Mr. M. B. Logan ...	20 July, 1908
Mr. J. C. Antinori ...	25 July, 1908
Mr. H. F. Pither ...	13 Aug., 1908
Mr. P. C. Douglass ...	17 Aug., 1908
The Viscount Hill ...	1 Oct., 1908
Mr. A. P. Thurston ...	1 Oct., 1908
Mr. J. C. Childs ...	1 Oct., 1908
Mr. C. J. Tozer ...	1 Oct., 1908
Mr. A. Worswick ...	20 Oct., 1908
Mr. C. C. Turner ...	5 Nov., 1908

To be honorary members:

Mr. Wilbur Wright ...	9 Nov., 1908
Mr. Orville Wright ...	9 Nov., 1908

2. It was decided to present the gold medal of the Society to Messrs. Wilbur and Orville Wright in recognition of their "distinguished services to Aëronautical Science."

At a Council Meeting of the Aëronautical Society of Great Britain, held at the Royal Society of Arts, John Street, Adelphi, on December 8th, 1908.

1. The undermentioned gentlemen were elected members of the Society:

Mr. M. B. Field.
Mr. G. R. Hubbard.
Col. H. S. Massy, C.B.
Mr. W. H. Sykes.
Mr. Howard Wright.
Capt. F. W. Marriott.

To date December 8th, 1908.

1. At a Council Meeting of the Aëronautical Society of Great Britain, held at the Meteorological Office, Victoria Street, Westminster, on December 31st, 1908, the following ladies and gentlemen were elected Members of the Society:—

Mr. A. Baxter.
Mr. J. T. Bateman.
Mr. S. Couper-Coles.
Mr. J. Conchie.
Mr. R. Deane.
Mr. H. Eschereze.
Capt. H. R. Hayter, A.S.C.
Mr. W. C. Johnson.
Mr. F. E. Larkins.
Mrs. Edwin Macintosh.
Mr. H. F. Marriott.
Mr. C. A. Moreing.
Mr. J. F. Ogilvy.
Mr. Alan Owston.
Count G. N. Plunkett.
Mr. W. H. Pibel.
Mr. G. A. Peache.
Mr. I. I. Redwood.
Sir Charles Seeley, Bart.
Mr. L. Sutton.
Mrs. Bernard Shaw.
Col. H. E. Tyler, R.E.
Mr. L. G. H. Walford.
Mr. J. A. Williams.

To date December 31st, 1908.

MISCELLANEOUS NOTICES.

1. The following books and publications have been presented to the Library:

By Colonel Trollope (late Grenadier Guards).

"La Conquête de l'Air" (current numbers).

"Proceedings of the Permanent International Aëronautical Commission, 1908."

By Major B. Baden-Powell (late Scots Guards).

The "Art of Flying," by Walker.

"Aërodynamics," by Prof. Langley.

By Messrs. Constable & Co.

"Aërial Flight," by F. W. Lanchester.

Vol. I.—Aërodynamics.

Vol. II.—Aërodonetics.

By V. S. Frank, Esq.

Photographs of Various Flying Machines.

By Sir Hiram Maxim.

"Artificial and Natural Flight."

By Messrs. Charles Griffin & Co.

"Oil Motors," by G. Lieckfeld, C.E. (sole authorised English edition).

2. The Press Cuttings supplied to the Society during December Quarter will be available for issue on January 16th, 1909. Any member who wishes to have them should apply to the Hon. Secretary on that date. They will be given to the first applicant.

3. Members and others contributing to the Journal are requested to kindly observe the following rules when drawing up their MSS.:

(*a*) Write on one side of the paper only.

(*b*) Leave a margin one inch wide on the left-hand side.

(*c*) Draw diagrams, etc., on very white paper with very black ink, as this greatly simplifies reproduction.

(*d*) Forward their communications to the Hon. Secretary at least 14 days previous to the date of the meeting at which the paper is to be read. Papers containing diagrams, sketches, etc., which it is required to show on lantern slides, should be sent in as early as possible.

4. The Kite Flying Association.—Members interested in kite flying should apply to the Secretary of this Institution for information regarding its objects, etc.,

W. H. Akehurst, Esq.,
27, Victory Road,
Wimbledon.

The Association is not formed to compete with the Aëronautical Society of Great Britain.

5. The attention of members and collectors is drawn to the fact that the Library has some spare copies of pamphlets for sale. A list of them will be sent on application to the Hon. Secretary.

6. The undermentioned gentlemen have kindly consented to serve on the "Travel Exhibition":

Chairman: F. Handley Page, Esq.

Members: G. P. Saul, Esq.
T. O'B. Hubbard, Esq.

Members willing to lend models, books, designs, etc., are invited to so inform the Chairman at

60, The Crescent,
Charlton,
Kent.

7. The Committee in charge of the Experimental Ground will be composed as follows:

Chairman: Major Baden-Powell.

Members: The Viscount Hill.
R. M Balston, Esq.

(With power to add to their numbers.)

8. Members of the Society will be pleased to hear that the Society of Engineers has awarded the Bessemer Premium to

Herbert Chatley, Esq., B.Sc.,
Member of the Aëronautical
Society of Great Britain,

for a paper on "Mechanical Flight" recently read by him at that Institution. This is almost the first occasion on which the Engineering Profession has rewarded a student of Aëronautical Science, and it is very satisfactory to find that work in this field of labour is appreciated.

Fig. 11.

GOLD MEDAL

OF THE

AËRONAUTICAL SOCIETY OF GREAT BRITAIN

PRESENTED TO

WILBUR AND ORVILLE WRIGHT,

IN RECOGNITION OF THEIR DISTINGUISHED SERVICES TO AËRONAUTICAL SCIENCE.

Messrs. WILBUR & ORVILLE WRIGHT.

Letter from Mr. Wilbur Wright.

In accordance with the decision of the Council, letters were written to Mr. Wilbur and Mr. Orville Wright, asking them to accept the gold medal of the Society in recognition of their distinguished services to Aëronautical Science, and informing them that they had been elected honorary members of the Society.

The reply of Mr. Wilbur Wirght is given below:

Le Mans,
December 3, 1908.

DEAR SIR,

I have your letter of November 21, and beg to request that you will convey to the Aëronautical Society my most sincere thanks for the honours which it has accorded to my brother and myself.

It would give me great pleasure to be present at your meeting next week, if it were practicable to do so, but my engagements make it very difficult to be in London at that time.

I am hoping that I will be able to persuade my brother to spend a few months in Europe in the near future, and that we may have the pleasure of making a visit to England together before the winter is over.

Yours very truly,
(*Signed*) WILBUR WRIGHT.

The following letter, written by Mr. Orville Wright to Mr. P. Y. Alexander in 1905, is of considerable interest, as it explains clearly the work which had been actually accomplished by Messrs. Wilbur and Orville Wright at that date:

Wright Cycle Co.,
1127, West Third Street,
Dayton, Ohio,
November 17, 1905.

DEAR MR. ALEXANDER,

We have finished our experiments for this year, after a season of gratifying success. Our field of experiment, which is situated 8 miles east of Dayton, has been very unfavourable for experiment a great part of the time owing to the nature of the soil and the frequent rains of the past summer. Up to the 6th September we had flown the machine on but eight different days, testing a number of changes which we had made since 1904, and as a result, the flights on these days were not as long as our best ones of last year. During the month of September, we gradually improved in our practice, and on the 26th made a flight of a little over 11 miles. On the 30th we increased this to 12 and one-fifth miles, on October 3, to fifteen and one-third miles, on October 4, to twenty and three-fourth miles, and on October 5, to twenty-four and one-fourth miles. All these flights were made at about thirty-eight miles an hour, the flight of the 5th occupying 38 minutes and 3 seconds. Landings were caused by the exhaustion of the supply of fuel in the flights of the 26th and 30th of September, and 5th October, and in those of October 3 and 4, by the heating of bearings in the transmission on which oil cups had never been fitted. But before the flight on the 5th October, oil cups has been fitted to all of the bearings and the small gasolene can had been replaced with one that carried enough fuel for an hour's flight. Unfortunately, we neglected to refil the reservoir just before starting, and as a result the flight was limited to thirty-eight minutes. We had intended to place the record above the hour, but the attention these flights were beginning to attract compelled us to suddenly discontinue our experiments in order to prevent the construction of the machine from becoming public.

The machine passed through all of these flights without the slightest damage. In each of these flights we returned frequently to the starting point, passing high above the heads of the spectators.

If you think the contents of this letter would be of interest to the members of the Aëronautical Society of Great Britain, you are at liberty to communicate as much of it to them as you please.

Hoping that we may have the pleasure of seeing you on your next visit to America,

I beg to remain,
Very respectfully yours,
(*Signed*) ORVILLE WRIGHT.

GENERAL MEETING.

The third meeting of the 43rd Session of the Aëronautical Society of Great Britain was held at the Royal Society of Arts on December 8th, 1908. The chair was taken by the President of the Society, Mr. E. P. Frost, D.L. (Cambs.).

In opening the meeting the President said: Ladies and Gentlemen, we meet, I am sure I may say, under auspicious and encouraging circumstances, for though much has yet to be done to improve the aëroplane, great progress has been made, and mechanical flight has at last actually been accomplished. I do not want to occupy much of your time with what I have to say, but there is one thing to which I must draw your attention, and that is, that the gold medal of the Society has been offered to, and accepted by, Messrs. Wright Brothers. (Applause.) Before introducing the gentleman who will read the first paper, I might say that we hope for, and invite, discussion this evening on what I trust will be very interesting papers. Will every member who wishes to speak kindly send his name and address up to our Honorary Secretary, Colonel Fullerton, or, if he prefers it, send a written criticism to that gentleman later on?

I will now ask Colonel Fullerton to read a letter he has received from Mr. Wilbur Wright.

Colonel FULLERTON, R.E., read the letter, dated December 3rd, 1908, from Mr. Wilbur Wright, conveying his most sincere thanks to the Aëronautical Society of Great Britain for the honour accorded to his brother and to himself. It was not possible for him to be at the meeting, but he hoped to persuade his brother to visit England before the winter is over. Continuing, Colonel Fullerton said: I may say that we have also asked these gentlemen to be honorary members of the Society, and I hope we shall have the pleasure of seeing them at one of our meetings a little later on. (Applause.)

C. E. FROST, Esq. (President): I will now introduce the gentleman who has kindly undertaken to read the first paper. Mr. Lanchester has for many years been working at the question which interests us so much, and he has published two very interesting and instructive volumes on Aëronautics. He has seen the machines he describes, in action, and has also discussed the details of their construction with their designers. I feel sure that his observations will not only be strictly accurate, but will be most interesting to all of us. (Applause.) I now call on Mr. Lanchester to read his paper. (Applause.)

F. W. LANCHESTER, Esq., who was cordially greeted, read a paper on "The Wright and Voisin Types of Flying Machine."

The Wright and Voisin Types of Flying Machine.

A Comparison.

By F. W. LANCHESTER.

Paper read before the Aëronautical Society of Great Britain, December 8, 1908.

The most successful types of flying machine or aërodrome at present in existence are those constructed by the Brothers Orville and Wilbur Wright, of the U.S.A., and by MM. Voisin frères of Billancourt, on the outskirts of Paris. The author of the present paper has recently had opportunities of witnessing both types of machine in flight, the former at the champ de manœuvres at Champagné, near Le Mans, the latter in the hands of Mr. Farman, over the ground of the military camp at Mourmelon le Grand, near Chalons.

Although accurate information is on some points difficult to obtain, the reticence shown is perhaps no more than might be anticipated. The author has succeeded in collecting sufficient data to be able to give a consistent account of the performance of both machines, and to permit of an intelligent comparison being made between the two systems.

The Wright Machine: Origin and Description.

The Wright machine can, metaphorically speaking, trace its ancestry back to the gliding apparatus of Otto Lilienthal; according to Gustave Lilienthal (brother of the famous aëronaut), two Lilienthal machines were sent to the United States, one to Octave Chanute, the other to Herring. Chanute and Herring are said to have been associated in their experimental work. The gliding machine, originated by Lilienthal, was improved, especially as to its structural features and its method of control, successively by Chanute and the Brothers Wright, until the latter, by the addition of a light-weight petrol motor, and screw propellers, achieved, for the first time in history, free flight in a man-bearing machine propelled by its own motive power.

The Wright machine of the present day weighs complete when mounted by aëronaut, 1,100 lbs. (500 kilos.), and has a total supporting surface measuring approximately 500 sq. ft., the ordinary maximum velocity of flight is 40 miles per hour, or 58 ft. per sec. (= 64 kilometres per hour). The aërofoil consists of two equal superposed members, of 250 sq. ft. each, the aspect ratio (lateral dimension in terms of fore and aft) is 6.2, the plan form is nearly rectangular, the extreme ends only being partially cut away and rounded off. The auxiliary surfaces consist of a double horizontal rudder placed in front, and a double vertical rudder astern, also two small vertical *fixed* fins of half-moon shape, placed between the members of the horizontal rudder. The total area of these auxiliary surfaces is about .3 of that of the aërofoil, or, say, 150 sq. ft.

The Wright machine is propelled by two screws of 8 ft. 6 in. dia. (2.6 metres), and so far as the author has been able to estimate the *effective* pitch is somewhat greater, being about 9 ft. or 9 ft. 6 in. These propellers are mounted on parallel shafts, 11 ft. 6 in. (3.5 metres) apart, and are driven in opposite directions by chains direct from the motor shaft, one chain being crossed. The number of teeth of the sprocket wheels, counted by the author, gave the gear ratio 10 : 33.

The motor is of the four-cylinder vertical type, the cylinder dimensions being variously given as from 106 to 108 mm. dia., by 100 to 102 mm. stroke, the probable dimensions being, in inches, $4\frac{1}{4}''$ by $4''$. The total weight of the motor is reputed to be 200 lbs. (90 kilos.), and its power is given as 24-b.h.p., at a normal speed of 1,200 revs. per minute. According to another source of information, it is capable at a speed of 1,400 revolutions of developing 34-b.h.p., the two statements do not altogether agree.

In conversation, the author understood Mr. Wright to say that he could fly with as little as 15 or 16 h.p., and that his reserve of power when unaccompanied amounted to 40 per cent.* His gliding angle, he said, was about 7°

The Voisin Machine; Origin and Description.

MM. Voisin began their experimental work some years before their name was known to the general public, or rather some years before their machines came into public prominence through the exploits of Farman and Delagrange, for comparatively few people even at the present time are even aware of the name of the makers of these most successful machines. In 1904, MM. Voisin constructed for Mr. Archdeacon some cellular kites of a large size, of very much the form of their present type of machine. These were tested in tow of a motor launch on the Seine, and provided much of the data that MM. Voisin afterwards utilised in the construction of the actual flying machines that brought their work into public prominence.

The MM. Voisin and their engineer or works manager, M. Colliex (who is largely responsible for their designs), make no secret of the fact that they have based their work on that of pioneers such as Lilienthal, Langley, and others, and in fact they say that they never miss an opportunity of utilising any information or data on which they can lay hands. On the other hand, much of their work is based on their own researches; they appear to take little for granted, having equipped themselves with an "artificial wind" apparatus, with which they test their work on a small scale before finally settling a design.*

The Voisin factory is on a comparatively small scale, the output and work in hand at date includes (amongst others) some 5 machines of the Farman-Delagrange type, and 4 machines of a modified pattern, with an aërofoil consisting of 3 superposed members. The former is the only type of machine for which flight data are to hand, and in the remarks that follow it is this type to which reference is made as the *Voisin machine*.‡

* The author is of opinion that although there may be nothing altogether inexact in this statement, it is, unless qualified in some way, capable of conveying an erroneous impression.

* It is of interest to note that MM. Voisin and their staff are entirely responsible for the design of their machines, and *guarantee that they will fly*. The purchaser pays for his machine in part as a deposit and the remainder *when the machine has actually flown*. It is time that the false impression that has been conveyed to the public by the press should be dispelled. Messrs. Delagrange and Farman (Voisin's first customers) had no more to do with the design of their machines than the purchaser of a motor car from the manufacturer.

† So far as the author is informed, the "triplane" type of Voisin machine (Goupy 1) has not performed so well as the earlier model (Farman type), though this may be due to the short time that it has been in the hands of the aeronauts. The author believes that the three members of the aerofoil are relatively too close

It appears from statements made to the author by MM. Voisin (and confirmed by Mr. Farman himself) that when their designs were prepared the first order they obtained was from M. Delagrange, and the second from Mr. Farman, who placed his order for what was practically a duplicate machine. That Farman made successful flights before Delagrange was due in the main to the fact that he had made in advance appropriate arrangements for testing and trials on the Champ de Manœuvres at Issy des Moulineaux, a precaution that the latter neglected, and it would seem that it is hopeless to attempt to fly, at least with a new machine, without some such provision. It also appears that the Delagrange machine went through some kind of a history in its early state, the wheels fitted in the first instance not being arranged as it was subsequently found necessary to arrange them, namely, as castors, or as the French express it, "orientable." It is this provision that takes care of any slight side component of the wind when starting and alighting which might otherwise upset the machine.

The Voisin machine is given as weighing complete with Mr. Farman "up," 1,540 lbs. (700 kilos.), and has a total supporting surface of 535 sq. ft., this being the combined area of the horizontal members of the aërofoil and the tail, both being used for sustentation, although there are reasons for supposing that the pressure per sq. foot on the aërofoil is greater than on that of the tail.

The ordinary maximum velocity of flight is approximately 45 miles per hour, or 66 ft. per sec. (= 72 kilometres per hour).

In addition to the horizontal sustaining members of the aërofoil and tail, there are a number of vertical members whose function is to preserve and control the direction of flight and to give lateral stability; these have a total area of approximately 255 sq. ft.

The supporting surfaces of both aërofoil and tail are of rectangular plan-form, the former being 10 metres by 2 metres, and, therefore, having an aspect ratio = 5.

to one another for best efficiency; their aspect ratio also is not good. Beyond this the position of the propeller (in front) is one not conducive to the best efficiency and the race of the propeller in such a position may materially add to the body resistance

The aspect ratio of the tail members is 1.25, they are nearly square.

The Voisin machine is propelled by a single screw of 7 ft. 6 in. dia. (2.3 metres), of which the *effective* pitch is approximately 3½ ft. (the actual pitch is much greater, the "slip" being excessive). The propeller is keyed direct to the motor shaft.

The motor fitted to the Voisin (Farman) machine is an 8-cylinder "Antoinette," 4.35″ dia., by 4.15″ stroke (110 mm. by 105 mm.), stated to give 49-b.h.p. at 1,100 revs. per min.; its weight is given as 265 lbs. (120 kilos.).

It is said that the gliding angle of the Voisin machine was at first approximately 1 : 5 or 11 degrees, but that by detail improvements in diminishing frame-work resistance by rounding off and covering in, to form stream-line sections, the gliding angle has been improved, and is now about .16 radian, that is, between 1 : 6 and 1 : 7, or 9 degrees approximately.

Comparison of the Two Machines.

Weight.—The first point to which we may direct our enquiry is that of the difference of weight; the Voisin machine is 40 per cent. heavier than that of the Brothers Wright. Since the passenger accommodation of the two machines is almost identical (both machines have shown themselves capable in raising one person of ordinary size in addition to the aëronaut), it might be supposed that the less weight of the Wright machine is a definite advantage, in fact, it might be thought that the less weight betokens more scientific design; claims in this direction have, in fact, from time to time been made.

There is, however, one feature in which the machines differ, and which is unquestionably responsible for much of the difference in weight. The Voisin machine is fitted with a "chassis" with four wheels mounted to swivel freely, this being an essential feature of a well-designed alighting mechanism, the front wheels are provided with a spring "suspension" to diminish the shock of landing or consequent on starting or alighting on rough ground. The Wright machine has no such provision but possesses instead a pair of wooden runners of comparatively little weight.

The total weight of this "chassis" of the Voisin machine is said to exceed one hundredweight (50 kilos.), and even if this is an exaggeration it certainly cannot be far short of that amount, and probably exceeds the corresponding weight carried by the Wright machine by at least 60 or 70 lbs. Now the total *inert* load carried by the two machines is otherwise about the same, and may be taken as about 200 lbs., representing the aëronaut and sundries, and it is evident that other things being equal, the total weight of the machine should be proportional to the inert weight it has to raise, that is, in the ratio of 200 lbs. to 270 lbs. or thereabouts, and thus the greater weight of the Voisin machine is in most part explained.

If the runners of the Wright machine would do all that can be done by the Voisin mounting, then this additional weight would not be justified, but they will not do so. The Voisin machine can rise by itself from any reasonably smooth surface, the Wright is unable to take flight without its launching gear,* hence it is not legitimate to attribute its relative lightness to the superiority of its design.

Horse Power.—The next point of comparison is that of the horse power employed as related to the weight and velocity, thus touching on the question of the relative efficiency of the two machines.

The author has shown† that for equal perfection of design the resistance to flight of two machines of equal weight is approximately independent of the velocity of flight, consequently the h.p. will vary directly as the velocity of flight, and the Voisin machine is entitled to more power not only on account of its greater weight but also on account of its greater velocity, in the absence of more exact information we may take the velocity of the Voisin machine as being 10 per cent. greater than that of the Wright; this is roughly in accordance with the figures already given.

* It has been recently reported that the Wright machine has undergone alterations, by which it is enabled to rise from the ground by its own power; whether the machine has been fitted with permanent wheels, or whether it is mounted temporarily on a trolley, which it leaves behind when it rises, the account does not say; probably it is the latter.

† "Aerial Flight," Vol. II.; *Aërodynamics*, Ch. VII.

The declared b.h.p. of the motors is sometimes not very reliable, it is customary to use the expression in a rather elastic manner. Let us make an estimate based on the cylinder dimensions and revolution speed of the two engines, assuming the same mean pressure for both. Employing the figures already given, and for the purpose of comparison assuming a mean pressure = 72 lbs. per sq. in. ***as appearing at the brake***, we have, at the speeds corresponding to the declared b.h.p.:

			B.H.P.
Wright	**4·25″ × 4″**	**@ 1200 revs.**	**24·7**
Voisin (Antoinette)	**4·35″ × 4·15″**	**@ 1000 revs.**	**49·2**

which agree remarkably well with the declared h.p. in both cases.

It is still a question whether the declared speeds of revolution are those actually employed in flight. The author believes that in both cases the speeds are, if anything, under stated, at least for the ordinary conditions of flight; they may, however, be taken in good faith, and we accept as a fact that the b.h.p. supplied to the Voisin machine is almost exactly double that fitted to the Wright.

On the above basis the Wright machine is fitted with 1 b.h.p. for every 45 lbs. sustained, which rate would give the Voisin machine 34 b.h.p., or, allowing for the difference in the speed of flight, 38.5 b.h.p. should be sufficient to place the machines on an equal footing. But the actual b.h.p. of the Voisin is 49.2, or an excess of about 28 per cent., and this excess must either be accounted for as a *surplus of power*, the measure of which is the rate that the machine can increase its altitude, or it represents a loss of efficiency in the propulsion or sustentation.

Now there does not seem to be any substantial difference between the reserve lifting power of the two machines, they both appear to have about ten or at most twenty per cent. surplus power. Mr. Wright has claimed more, but the performance of his machine does not seem to bear out his claim.* We may conse-

* The rate of increase of altitude of a machine having a reserve of 40 per cent. would be quite sensational. Thus at 1,000 metres per minute velocity, the power required for horizontal flight may be represented by a loss of altitude of about 130 metres per minute, and an additional 40 per cent. would give an actual rate of ascent of over 50 metres per minute. The Wright machine does not, in the author's opinion, show so great a capacity of ascent. At the time of the author's visit a passenger of about 60 kilos. weight was being

quently infer that the loss of power in the Voisin machine is correctly represented by the foregoing figures.

We will now endeavour with the data at our disposal to ascertain the cause of the loss of efficiency in the Voisin machine. The flight velocity and the motor revolution speed (together with the ratio of the gear reduction in the case of the Wright machine) allow us to calculate the *effective pitch* of the propellers we already know their diameter, and from the pitch diameter ratio we can form a close estimate of their efficiency, we shall then be able to form an estimate of any remaining difference in the efficiency of the two machines.

Without going into the method by which the computation of the propeller efficiency is effected, it may be remarked that the method involves the assumption that in each case the designers have approximately determined the form of best efficiency under the restricted conditions of the pitch-diameter ratio adopted. That this assumption may not always be correct is obvious, but that it is somewhere near the truth in the two cases under discussion the author has been able to satisfy himself.

The method beyond this consists of a simple and elementary application of the principles laid down in the author's "Aërodynamics," Ch. IX.

Firstly, to determine the effective pitch. This, in the case of the Voisin machine, is given by the distance travelled, divided by the number of revolutions in the same time. In the Wright machine the result has to be multiplied by the gear ratio. In the case of the Voisin machine we have 66/18.3 = 3.6 ft., as the effective propeller pitch; in the Wright machine we have $\frac{58 \times 33}{20 \times 10}$ = 9.6 ft., or, the diameter in terms of effective pitch in the two cases is: Voisin, 2.1; and Wright, .88.

The efficiencies found by the author as appropriate to these pitch ratios are respectively: Voisin, .54; Wright, .68, or deducting in the latter case 5 per cent. on account of the chain drive (certainly not a too great allowance for the power consumed by a chain running at about 16 ft. per sec.), we have the total efficiency of propulsion:

Voisin ... ... .54
Wright ... ... .63

In the table that follows, col. 1 gives the foot-pounds given out by the respective motors per revolution on the basis already employed, *i.e.*, 72 lbs. per sq. in. mean pressure. Col. 2 gives the feet traversed by the machine per motor revolution. Col. 3 gives the efficiency of propulsion as above. Col. 4 gives the thrust in pounds calculated from the three proceeding columns. Col. 5 gives the weights of the machines augmented by an amount that we have estimated would absorb the whole thrust in horizontal flight, that is, the maximum weight that can be sustained in flight. Col. 6 gives the resulting value of tan γ, and Col. 7 gives the equivalent in degrees. (γ is the gliding angle.)

	1. Ft. lbs. per rev.	2. Ft. p. rev.	3. Effcy.	4. Lbs. thrust.	5. Wght.	6. Tan γ.	7. $\gamma°$.
Wright ..	708	2·9	68	155	1300	·12	7°
Voisin ..	1550	2·6	·54	230	1720	·135	7° 40'

It would thus appear that in addition to being considerably less efficient in its screw propeller (a tax paid for the constructional advantage of a direct drive), the Voisin machine is also slightly less efficient considered as a glider, that is to say, its gliding angle is not quite as good as that of the Wright machine—the machine is *aërodynamically* less efficient.

The reason of this may be due to the fact that it has a less aspect ratio, but it may quite well also be due to many other causes; the Voisin machine has relatively greater idle surface subject to skin friction, also the sustaining surfaces of the tail act on air that has already been trodden by the aërofoil. The author is

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carried, the machine should still have been able to rise at a rate of over one metre in two seconds.

It is on record that on one occasion Mr. Wright took up with him a passenger weighing 100 kilogrammes, but, on the other hand, on another occasion he failed after repeated attempts to raise another passenger of approximately this weight; it may consequently be inferred that an addition of 100 kilos. to the 500 kilos. normally carried, that is, an addition of about 20 per cent., represents approximately the limit of the capacity of the machine.

Beyond this, Mr. Wright has admitted (at least to the author), that his gliding angle is about 7 degrees; this, at a gross weight of 1,100 lbs., gives 140 lbs. thrust required, and at 58 ft. per sec., the thrust h.p. becomes 14.5. Now Mr. Wright also agrees 24-b.h.p. as the power of his motor, which, if 40 per cent. in excess of his requirements, gives 17.1 b.h.p. as ordinarily utilised, or the total efficiency of gear and screw propeller would be 85 per cent.—a manifest impossibility.

If Mr. Wright's statement may be taken to mean that the *thrust* h.p. required is about 15 to 16 h.p., and that his reserve of power is 40 per cent. to include that lost in propulsion, then the whole matter is clear. It is possible that the author misunderstood Mr. Wright's meaning.

not altogether satisfied that the gliding angle is actually as low as that deduced above; it is possible that the motor (with the machines at the velocity stated) in both cases runs somewhat faster than that declared, and that consequently the pitch of the propellers is proportionately less, since this has been deduced from the revolution speed. An error of this kind, so long as it is much the same for both machines, would not materially affect the results except that in both cases the gliding angle would be proportionately greater; the error may possibly amount to as much as 10 per cent.

It is also worth while noting that what is termed the mean or actual pitch of the propeller blades will be greater than the effective pitch. The pitch as measured from the blade angle is probably in the Wright propeller about 15 per cent. more than the effective pitch, and in the Voisin about 25 per cent. On this basis the Voisin 3.6 ft. becomes 4.5 ft. (= 1.37 metres), and the Wright 9.6 ft. becomes 11 ft. (= 3.35 metres).

Taking the gliding gradient tan γ for the Wright machine as .135, and that of the Voisin machine, .150, values which the author considers most probably a close approximation to the truth, we may roughly look upon the resistance as accounted for as follows:—

	Wright. Lbs	Voisin. Lbs.
Skin-friction, ξ = ·01 ..	40	60
Struts and wires	30	20
Aeronaut, motor, etc ..	20	10
Radiator and tanks	5	25
Alighting gear	—	10
Sustentation (power expended aerodynamically) ..	60	100
	155	225

The above do not correspond exactly with the suggested values of tan γ, but they are as near as the author can estimate at present. The total in the case of the Wright machine is a trifle high, and that of the Voisin is a little low. Possibly the fault is with suggested values themselves, and there is really less difference between the gliding angles than has been supposed.

In conversation with the author, Mr. Wilbur Wright has stated that he makes no allowance for skin friction, and that he believes it to be negligible. There is evidently considerable scope yet for guess-work. It is quite likely the designers themselves could not give a much better approximate balance-sheet of the resistance account than that here presented. It is possible that the coefficient of skin friction ξ is less than .01; for these large surfaces and high velocities it is conceivably no more than half this value. It is equally possible that the other direct resistances, struts, wires, etc., have been underestimated; there may also be faults of as much as 10 or 15 per cent. in the estimate of the energy expended in sustentation, but it is quite certain that skin-friction is not negligible, but that it is a substantial quantity of the order indicated; it is also quite certain that the gliding angle of the machines is round about the values given 1 : 6 to 1 : 8, and is nowhere near 1 : 12 as has been stated in a recent paper on the subject; it is also improbable that the efficiency of propulsion is in any case as high as 75 per cent., as it has sometimes been represented (in the case of the Wright machine), although it may in both cases be a few per cent. greater than given in the present paper.

On the whole the advantage certainly rests with the Wright machine from the aërodynamic standpoint.

Stability.—We now pass on to consider the question of stability and control.

(*A.*) *Longitudinal stability.*

In the case of the Wright machine it is claimed by Mr. Wright himself that the stability depends entirely on the skill and address of the aëronaut; in fact, if we are to credit the account of Mr. Wright's declaration on the subject*, he does not believe in the possibility of safety, under ordinary weather conditions, being achieved by the inherent properties of the machine. He says that sooner or later the fatal puff must come that will end the flight.

The author's own observations on the flight of the Wright machine fully confirm the statement that *Mr. Wright does depend entirely upon his manipulative skill.* It appears that in flight the leading planes travel through the air, carrying little or no load; in the ordinary conditions of straight flight their direction is as nearly as can be estimated parallel to the *frame* of the main aërofoil, and both

* See account of speech at banquet given by Aero Club de France, *New York Herald* (Paris Edition), November 3, 1908.

seem to move almost exactly edgeways. It follows from this that the machine cannot be automatically stable, for if the plane were *fixed* for any period of time, and if, during that period, the machine made the smallest pitching movement either one way or the other, the resulting change of pressure on the leading plane (or planes) would tend to exaggerate the initial movement, and the machine would turn over. The position of the machine, with the leading planes fixed, is comparable to an arrow travelling feather first, and this condition is one of instability.

In brief, not only does Mr. Wright design definitely for hand-controlled equilibrium, but he has no belief in the possibility of making a machine safe by its own inherent stability. The success of the Wright method shows that *there is at least more than one way to fly*.

In the Voisin machine, on the contrary, it has been the intention of the designer that the machine should be automatically and inherently stable, and unquestionably to a great extent he has succeeded. The author is at present compelled to speak with some reserve as to the degree of success that MM. Voisin have achieved; they have promised to supply particulars that will enable the point to be investigated, but up to the time of writing this promise has not been redeemed. In the meantime it may be remarked that the disposition of the organs of the Voisin machine are such as will give automatic stability if the following conditions are fulfilled:—(1) If the pressure is less (per sq. ft.) on the tail than on the main aërofoil, so that the *attitude* of the aërodrome to its line of flight is one of stable equilibrium; (2) if the areas and disposition of the surfaces, the amount of inertia, the velocity of flight, and the natural gliding angle are related to comply with the *equation of stability**, so that any oscillation in the vertical plane of flight will not tend to an increase of amplitude.

From the behaviour of the machine it is not possible to tell whether these conditions are complied with, because it is fitted with a horizontal rudder in front, by which the aëronaut can correct any departure from the straight line, and this appliance is unquestionably utilised to destroy any oscillation that would otherwise arise. It is a big rudder, about one-quarter the area of the aërofoil, and, skilfully handled, it would entirely mask the natural free oscillation period of the machine. From observation of the flight the author is of opinion that whether the machine has inherent stability or not, the actual fact is that its motion (in the sense under discussion) is just as much controlled by hand as the Wright machine. In the hands of a beginner the machine would, however, very likely be able to take care of the aëronaut to some extent, performing oscillations the while, until the aëronaut has learned to take care of the machine. This view is suggested by the fact that many of the observers who saw Farman and Delagrange early in their career witnessed the phugoid oscillation, whereas the author, who saw Farman only a few weeks back, could not detect any oscillation at all, except for a brief period after he first left the ground, and this in spite of the fact that the day was by no means calm; a very perceptible breeze was blowing.

M. Colliex, engineer to MM. Voisin, claims that the flight path of their machine is stable on the following grounds:—

(1) A one-tenth scale model showed itself quite stable in gliding flight.

(2) A machine mounted by Delagrange made a smooth glide to earth without the intervention of the aëronaut in any way when the ignition was cut off at 8 metres' altitude.

The first of these tests would be quite satisfactory if due precautions are taken to ensure that the model test is made under the conditions of corresponding speed. As a matter of fact, the velocity of the model was nearly half that of the full-sized machine, instead of slightly less than one-third, as it should have been. In consequence, it follows from the equation that its factor of stability was about three times that of the full scale machine, so that the experiment cannot be considered conclusive. The evidence of the flight of the actual machine in the hands of Delagrange also is insufficient, for the horizontal distance that the machine would glide from a height of eight metres' altitude would be approximately 55 metres, and this is scarcely more than one-quarter of a phase length. For this test to be considered satisfactory, the machine should be allowed some four or five free oscillations, and the phase length

* "Aerial Flight," Vol. II., *Aërodynamics*, Ch. V and VI.

being about 600 feet, this involves a flight path of about 3,000 feet length, or a fall of about 500 feet; that is, 150 metres. There is thus no proof at present forthcoming as to the stability or otherwise of the flight path of the Voisin machine, but it is at least the intention of the makers that it should be longitudinally stable, and, from conversations that the author has had with MM. Voisin and with their engineer, M. Colliex, they appear to be alive to many of the points that conduce to such stability.

(B.) Lateral stability.

In the Wright machine the lateral stability is under the direct control of the aëronaut. The "two wings" of the aërofoil being given a twist by straining the structure by means of wires arranged diagonally in the rear panels of the two end bays on either hand. This causes the wings to meet the air at different angles of incidence and so any desired turning moment about the axis of flight (within certain limits) is at command. This mechanism is employed to neutralise the influence of wind gusts, and to correct the position of the machine should it acquire an undesirable list. It is also utilised to prevent the machine canting too much when turning, and to facilitate its employment in this respect, the rudder aft and the twisting of the wings are operated by one lever, the motion to the right and left being utilised to put tension on the diagonal wires one way or the other, and the movement forward and backward works the rudder.

It is desirable to correct a false impression that is current on the action of the wing twist. It has been supposed by some that it is used to give the *cant* required by the machine when turning, but such is not the case. If the rudder is used the machine almost immediately gets a cant, owing to the greater pressure on the wing that in turning is moving faster through the air, and this cant becomes, if unchecked, far too severe. The twist is then used to check the cant, the wing on the outer circle (that is, farthest from the centre of curvature) being "feathered," the inner one having its angle of incidence increased.*

*A certain patentee sent the author a specification of his invention, in which a rudder was carefully arranged to act spirally, to give a cant in the direction of the banking, that is, the direction in which the turning moment is already excessive. He might be well advised to take out another patent for the same device, arranged to act in exactly the opposite way!

In the Voisin machine no hand adjustment is provided to enable the aëronaut to control the lateral stability, hence in this case it is definitely automatic. The Voisin machine is steered by means of a vertical rudder arranged between the fixed tail members, and there is apparently no special mechanism to prevent the over-canting; consequently, Farman, in his flights, commonly turns in a leisurely manner, employing a circle of considerable radius, whereas Wright may often be seen to perform sensational evolutions, turning with his wings canted to nearly 30 degrees on a radius of, perhaps, not more than 60 or 70 yards.

It is of interest to note that Farman has recently had fitted to his machine some adjustable flaps to give in effect the wing twist employed by Wright. Presumably this is to facilitate turning, for the flight of the machine does not suggest that they are otherwise wanted; the lateral stability leaves little to be desired.

Summarising the comparison from the aërodonetic standpoint, the author is inclined to think that the Voisin machine has the advantage, as containing more of the features that will be embodied in the flying machine of the future. Mr. Wright's contention that it only requires a big enough puff of wind to upset a machine that depends upon its own inherent stability, is certainly true, but probably the same is equally true of the hand-controlled machine. There is a limit to the extent of the control that can be exercised, and with hand control we have, too, the possible failure of the human machine. The fact is, that the secret of stability is contained in the one word, *velocity*, and until it is possible to attain higher speeds of flight we cannot hope to see the flying machine in everyday use. The author believes that the future of flight as a useful and practicable means of aërial navigation will depend definitely upon the abolition of hand-maintained equilibrium and the substitution of automatic stability, and already the Voisin machine goes a considerable way in this direction.

There is one other point of comparison, that if space permitted the author would like to make. As it is, a few words must suffice.

The constructional methods employed by Wright and Voisin present a striking contrast. The Wright machine is astonishing in its simplicity—not to say in its apparent crudity of detail—it is almost a matter of surprise that it holds together. The Voisin machine has at least some pretensions to be considered an engineering job.

Mr. Wright defends his methods by asking what would be said by an engineer to the rigging of a sailing vessel if shown it for the first time, and, to some extent, the analogy is a good reply to the objection. Still, the author feels (perhaps wrongly) that there is a considerable amount of the Wright "mechanical detail" that might be revised with advantage; at least, before the machine is placed in the hands of the private user. However, "the proof of the pudding is in the eating," and in spite of the rudimentary character and aggressive simplicity of the constructional detail of the Wright machine, it appears not to come to pieces, but continues to fly day after day without showing any signs of weakness or disintegration.

On the question of the motor and transmission mechanism we tread on difficult ground, for the Voisin system of metal propeller keyed direct to the crank shaft is so immeasurably superior from the purely *mechanical standpoint* to the chain drive and wooden propellers of Wright that comparison is unnecessary. Since, however, the simple and direct arrangement adopted by MM. Voisin is paid for at the price of about a 15 per cent. tax on the transmitted horse-power, the question is evidently one of the balance of advantages and disadvantages that are of entirely different kinds. The author has reasons for supposing that if, in the machine of the future, the geared propeller survives (for it is essentially the use of *gearing* in the Wright machine that permits the better proportions of propeller to be used) it will be in the form of a propeller or propellers centrally situated, thus resembling the Voisin arrangement rather than in the distribution of propellers such as at present employed by the brothers Wright. The simplicity of the direct drive may, however, alone be sufficient to outweigh any economic advantages that gearing may possess.

I personally consider the Wright disposition of propellers to be a source of danger. If a torque is applied to an aërodrome about a vertical axis, rotation about this axis at once begins, and the outer wing, travelling through the air faster than the inner, experiences a greater lifting re-action, and if the torque is sufficient, the machine is very soon (in nautical phraseology) on its "beam-ends." It is evident that if one of the propellers fail from the fracture of a chain or other cause, unless the motor be instantly stopped, the whole power of the motor and, therefore, the whole thrust will be transmitted through the other propeller, causing a torque about a vertical axis that must be overwhelming. If the motor is promptly stopped then much will depend on whether the propeller that has failed is scotched or free. If it has jambed, then it will probably balance by its drag the other propeller, which is either stopped also or is driving the motor against its internal friction. If, on the contrary, it is free, then the drag of the other propeller will be unbalanced, and there is a serious torque in the opposite sense to that which would have existed if the motor had still been running. Whether Mr. Wright can, in the latter case, by wing twisting and other contortions, save himself from destruction I do not know. It is said that, a short time ago, a chain actually broke in flight, and the machine safely landed. The altitude when the accident occurred was stated to be only four or five metres, so that Mr. Wright did not have a fair chance of exhibiting his resources. It is to be hoped that he will not have such a mishap at a higher altitude.

Experiences with the Wright Machine.

By MAJOR B. BADEN-POWELL.

(With this paper were shown the following cinematograph pictures, by the Charles Urban Trading Company):

1. Mr. Wilbur Wright's Aëroplane Flights.
2. Gannets at Home.
3. The Gordon-Bennett Balloon Race in Paris, 1906.
4. The French Airship "La République."
5. The Zeppelin "Airship."

Fig. 12.—The "Wright" Machine in full Flight. [Topical Press Agency.

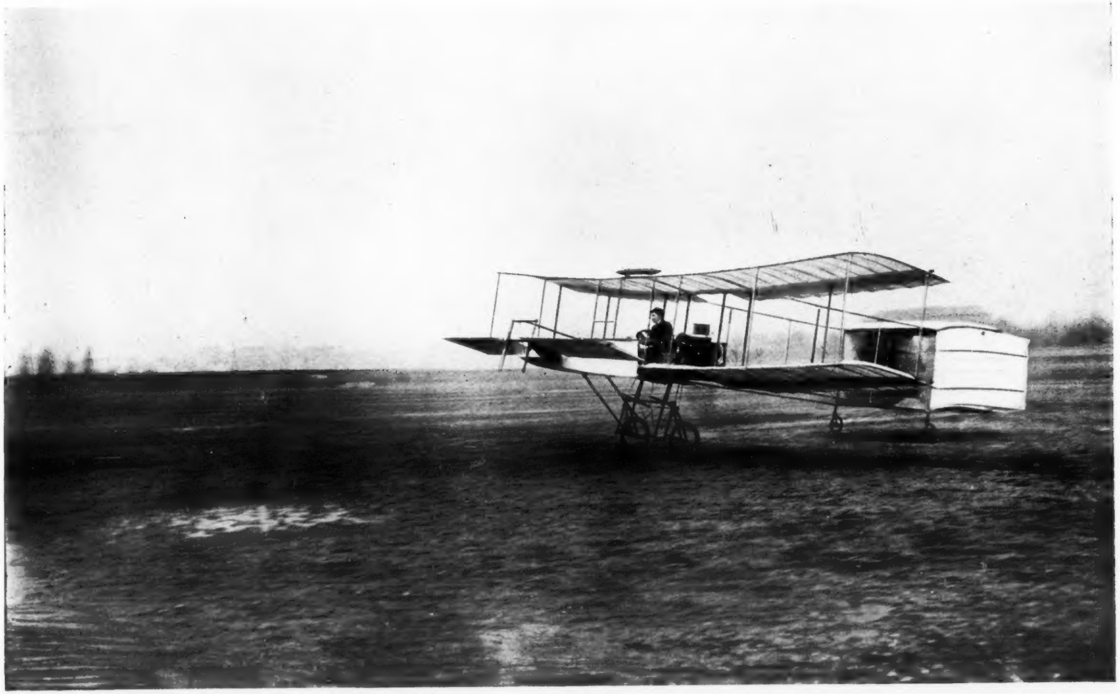


Fig. 13.—The "Voisin Type" Machine. [Topical Press Agency.

Major B. Baden-Powell (late Scots Guards), who was heartily greeted on rising, said: Mr. Chairman, Ladies and Gentlemen—You, sir, began by saying that you were now about to listen to my lecture. I am afraid that my lecture to-night will not be a very formal one. My only object is to say a few words about "Experiences with the Wright Machine." We have just heard from Mr. Lanchester a very able discourse on what we may call the scientific side of this machine. He has explained to us a great deal about the theoretical results attained, and, therefore, I think there is very little more to be said on that point. But when we hear these descriptions of this apparatus, and when we even see pictures of it, we, perhaps, don't realise to the full extent the exact behaviour of the machine until we actually see it in the air. Now, fortunately, such is modern science and invention, that by means of the cinematograph we are able to get a representation of such machines in motion, which give us a very fair idea of what the affair really looks like, and we hope to have to-night the cinematograph pictures of the Wright machine, which I am sure are exceptionally good. I saw these some little time ago in Paris, and I was very much struck with the beautiful representation that they gave of the machine, and I thought it would be very interesting for the members of this Society to have them reproduced here to-night. (Applause.) Before we get on to these I may as well give a short description of what we may call the surroundings of the thing. First of all we get to the town of Le Mans, and we find there rather a curious state of affairs. All the local people are keenly interested in these experiments, and there, in the Market Square, is a series of small motors and waggonettes and various other conveyances labelled "Service à l'Aëroplane," and they will take you out for a few francs a head to the grounds. I may say that I was at this place for over a week going out every day, so I saw a good deal of it. And each day several thousand people trooped out of Le Mans by these various methods to go out to the Camp d'Auvours, which is, perhaps, seven miles away from the town. It was an extraordinary sight to see all these people, from peasants to Princes, all wending their way out to see these experiments. Well, then, you get on the groûnd. The people are kept in order by a few troopers of the cavalry regiment which is stationed there, and, as you will see by these pictures, Mr. Wright's manager, Mr. Hart O. Berg, is always very much to the fore in managing all the arrangements, and frequently you will hear him shout "tout-le Monde en arriere" as he drives the crowd back before him. I may say that the ground consists of an open, flat, sandy plain, perhaps half a mile across by several miles long, and it is surrounded by trees, and the crowd and the people are kept to one side of this along the edge of the trees. Then we come to the shed where the aëroplane is housed, and it is also Mr. Wright's home, for he always camps out in his shed beside his machine, and a very primitive domicile it is. Then the doors are opened and the machine is drawn out sideways. You will now know the way in which the vertical rudders behind stick out at some distance. When the machine is in its house these are telescoped in to occupy less room, and you will notice that when the machine comes out of its shed they are in that position. They are then drawn out and fixed to their proper point. The machine has to be turned round and drawn off to the starting ground, which is some hundreds of yards away from the shed. And you will notice that there is one peculiarity about this machine, that though it has continually to be drawn about the ground, it has no permanent wheels attached to it. It seems rather a clumsy contrivance to tie a pair of wheels on to the machine to draw it away to the starting point, and then these wheels have to be untied and taken off the machine, and it makes its flight, and when it comes back these wheels are to be tied on again to tow it back to its shed. There is one point that I may as well mention, as you will see it in the pictures, that the speed of the machine through the air is measured by a little anemometer which is placed on one of the upright supports, and by this means Mr. Wright is able to ascertain exactly the speed that he makes through the air.

I think most of the details have been

so gone into by Mr. Lanchester that I need not occupy your time with them. Most of you know well the method by which the start is made. The "Pylon" consists of four upright beams braced together with a pulley near the top, and a heavy weight consisting of about six or eight iron discs of two hundred pounds is drawn up to the top of that, and the rope from this weight is taken down over certain pulleys and away to the far end of the track upon which the machine runs, and back to the machine. When the apparatus is ready to start, the anchoring arrangement is released so as to let the machine run along the track, pulled by the rope, and in that way it is drawn along at a very rapid pace. Now, you will notice in these pictures that the track consists of an upright beam of wood; that is to say, a board on edge which is supported on the ground by being pegged to it, and has a small rail on the top. This is about 100 feet long, and you will notice that the machine, resting on a small kind of carriage running on this rail, will progress along the rail for the greater part of the distance, and then, when Mr. Wright sees that the time is opportune, he raises his front planes slightly and the machine gradually rises up into the air. There is one point that struck me very much, and, perhaps, will strike most people, that you rather expect to see the machine, directly the releasing apparatus comes into effect, rise straight up, but it doesn't. It goes along almost horizontally, and very often you think that it is not off the ground—it looks as if it is running absolutely on the ground—it may be within two or three inches of the ground, and it gradually mounts into the air. I think you will see that is very clearly shown in the pictures. Now we can put on the pictures, and as they go on I can point out one or two more facts. You will see in the beginning I happen to appear myself. I was rather surprised to see this when I first saw the picture, but it was just a coincidence.

Cinematograph Pictures of the Wright Flying Machine were thrown on the sheet by the Urbanora Co.

Comments thereon were made by Major Baden-Powell as follows: Here is the machine being drawn out of its shed, and you see Mr. Berg, the manager. You see, it is being drawn out sideways, and here are the rudders telescoped into the machine. They are now turning the machine round on an axis so as to get it right way round—Mr. Berg comes to the fore again. You will notice the shape of these propellers is rather different from those you saw in the former pictures, this being a later type of the machine. They are now taking it out on its wheels. There's me. (Laughter and applause.) You see the Pylon in the distance—here it is, bigger. You will notice the temporary wheels placed here and there, which are always taken off. They are now putting the machine on the track which runs along here. You will notice the board on edge now. They now place it on a little trolley. Here is Mr. Wright adjusting the anemometer which is to tell his speed through the air. (Applause.) You will notice the smile that he puts on every now and then—it is a great feature of Mr. Wright—generally he looks very stern, but every now and then he bursts into a broad smile. There you see the men turning the propellers to start the engine. This, of course, is the radiator and the large petrol tank behind it. Now he has got his engine started. Mr. Wright always takes a lot of trouble about seeing it is all going well before he makes any flight. He runs his engines two or three minutes before he goes up. The propellers are still going round—the engine is running and he is adjusting small parts of it. Mr. Berg lights a cigarette. (Laughter.) He is adjusting his chain. Here you see the rope and the weights—Mr. Wright is getting into the seat ready to start. There always has to be a great deal of adjusting of caps and buttoning of coats, because of the pace you travel through the air. He grasps the levers to get them ready. Now he is making the engine do its full speed. Now he puts his hand to release the trigger. He has now started off. Now notice when he gets up. You see, he rises into the air. Now he is flying. (Applause.) Here he comes along again. You will notice how he very often flies along only a few feet from the ground—not necessarily at any great height. Now notice when he turns round. Now look out for the landing. You see, he is close to the ground, within a few inches almost—now he lands. (Applause.) Now he is up to see the machine taken home again. You see one of the cavalrymen galloping across to keep the crowd back. Here they bring up the wheels. You will notice Mr. Wright with his old bit of rope. It all looks very clumsy, but it is workmanlike. This is Mrs. Berg. Now you will notice the smile. (Laughter.) Here is the motor which draws up the weights and tows the machine home. (At the conclusion of the last slide there was much applause.)

Whilst we are about these cinematograph pictures I thought it very desirable to exhibit one or two more, which I think are bound to be interesting to members of the Society. There were certain pictures taken some little time ago by Mr. Kearton of birds in flight, and it is very interesting to watch their methods, because I think one can learn many a lesson from them. I will ask the operator to put the birds through at the ordinary pace first of all to show how they fly in Nature, and then later on to do it quite slowly so that one can see the action better of the actual motion of the wings. One of the peculiarities of this picture, I think you will notice, is that when a bird alights he has the peculiar way of putting his wings right over his back, and in that way gets a sort of parachute action, with the weight of his body very far below it. I think that is rather instructive as a method of landing. I don't say that it can be imitated very easily.

Cinematograph pictures of "Gannets at Home" were thrown on the sheet, at first showing the ordinary rate of flight, and secondly very slowly. The pictures were applauded.

Pictures of the Gordon-Bennett Balloon Race in Paris in 1906 were then thrown on the sheet and greeted with applause.

The dirigible balloon "La République" was then shown on the sheet, and, subsequently, the Zeppelin Airship. The latter was greeted with much applause.

At the conclusion Major Baden-Powell was heartily applauded.

The President: Our thanks are due to Major Baden-Powell for his interesting and delightful paper. To sit here and see these excellent pictures passing before us is, to my mind at any rate, nearly as good as seeing the machine itself. We offer, therefore, our thanks to Major Baden-Powell for his paper, and to Mr. Urban and the Kineto Company for the pictures which have so pleasantly entertained us this evening.

I will now call upon Mr. Cody to read his paper.

Experiences with the "Power Kite."

By S. F. CODY.

S. F. Cody, Esq., who was heartily greeted, spoke of his experiences with the "Power Kite." In the course of his address he said: Mr. Chairman, Ladies and Gentlemen,—I am afraid that my portion of the programme will have to be curtailed a great deal. My object in giving this short speech is to encourage English mechanics to assist the Government in obtaining flying machines equal to those abroad. Of course, as you know, I am an American citizen, but I have been in England now 18 years, and I am almost a British subject—but not quite. (Laughter.) Still, I serve the British nation, and while I serve I hope to serve to the best of my ability, and to try and encourage other people to do what I am trying to do myself and have been trying to do for a long time. I have been working very hard on the subject of aërial navigation for, I may say, some twelve or fifteen years, but money matters failing, I had to turn my hobby into manufacturing a kite in order to raise money to build a flying machine, or to put "power" into my kite, consequently the term "Power Kite." I have failed to raise that money, although to-day my kite is an equipment of the British Army. Some day I may get the money. I did hope to be the first man in the world to fly. I may say—though it would seem like boasting—I had the secret or the idea of an aërial surface, a lifting surface, the aërial curve proper, a good many years ago, and kept it to myself, like some other things I have kept to myself, and other people developed them. I didn't wish to divulge them in lectures in Societies or any other place. I hoped to get the money and do the thing like the Wrights have done. I know that no man was more enthusiastic over the Wrights' accomplishment three years ago, when it was first announced by Mr. Patrick Alexander in this Society's meeting, than I was. I simply expressed that I knew it all the time. It must come. It has come. And I am very proud to say it was by a citizen of my own country, although I am not sticking very fast to my country now. I hope that some time I may be able to do something good for them after I have done something good here. I have done very little to shout loud about, but still, I have accomplished one thing that I hoped for very much, that is, to be the first man to fly in Great Britain, the country I am living in, at the time mechanical flight became popular. I made a machine that left the ground the first time out; not high, possibly five or six inches only. I might have gone higher if I wished. I made some five flights in all, and the last flight came to grief for a reason I shall try to demonstrate or to show you on the blackboard, and may assist other experimenters in not coming to grief as I did. The accident will not occur again with me. I went out this morning. The curves of my machine are adjustable by screw adjustment. I can give them the deeper curve to set the whole machine in a deeper pitch whilst lying on the ground, or I can raise the wings in that position (demonstrating on blackboard) that way, or down this way, or turn them to the tips. The machine is somewhat heavy in order to give these adjustments, but I had to do it to decide which was the best position to give my curves. The Wright machine was not public property when I built mine. My machine was finished over three months before the Wright machine came out. You will notice the similarity of the Wright machine and mine; not only that, but the curves and the system of constructing the curves are precisely alike. I will be out again in about ten days' time. There is no secret kept about it. It is difficult, I know, but I try to do what I can. I have no objection to anyone coming and looking at it, none whatever. (Applause.) To start with, on the morning of the accident I went out after adjusting my curves and setting my propellers at 8-feet pitch running at 600. I think that I flew at about 28 miles an hour. I had 50-h.p. motor power in the engine. A bunch of trees, a flat common above these trees, and from this flat there is a slope goes down like that (demonstrating)—another clump of trees there. Now, these clumps of trees are a quarter of a mile apart or just about. In going out to my position I used to go up to the top here, and run over to the side of the trees to fly down. It was a jump down hill; I was accused of doing nothing but jumping with my machine, so I got a bit agitated and went to fly. I went out this morning with an easterly wind, and left the ground at the bottom of the hill and struck the ground at the top, a distance of 74 yards. That proved beyond a doubt that the machine would fly. It flew uphill. That was the most talented flight the machine did, in my opinion. Now, I turned round at the top and started the machine and left the ground—remember, a ten-mile wind blowing at the time. Then, 60 yards off where the men let go, the machine went off in this direction (demonstrating). I make a line now where I hoped to land—to cut these trees off at that side and land right off in here. I got here somewhat excited, and started down and saw these trees right in front of me. I did not want to smash my head rudder to pieces, so I raised it again and went up. I got one wing direct over that clump of trees, the right wing over the trees, the left wing free; the wind, blowing with me, had to lift over these trees. So I consequently got a false lift on the right side and no lift on the left side. Being only about eight feet from the tree tops, that turned my machine up like that (demonstrating). This end struck the ground shortly after I had passed the trees. I pulled the steering handle over as far as I could. Then I faced another bunch of trees right in front of me. Trying to avoid this second bunch of trees I turned the rudder and turned it rather sharp. That side of the machine struck, and it crumpled up like so much tissue paper, and the machine spun right round and struck the ground that way on, and the framework was considerably wrecked. Now, I want to advise all aviators not to try to fly with the wind and to cross over any big clump of earth or any obstacle of any description unless they go square over the top of it, because the lift is enormous crossing over anything like that, and in coming the other way against the wind it would be the same thing when you arrive at the windward side

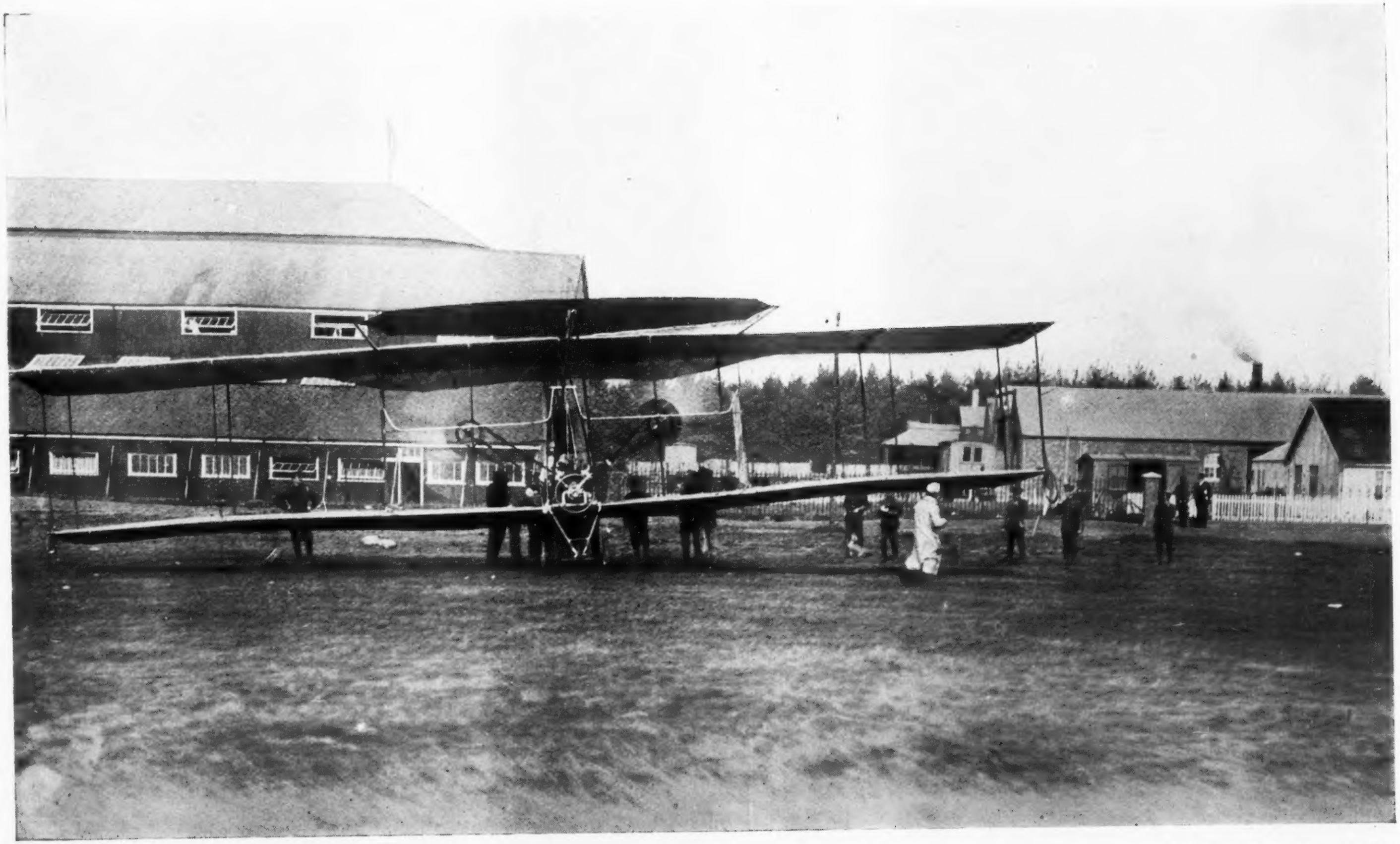


Fig. 14.—The "Cody" Power Kite.

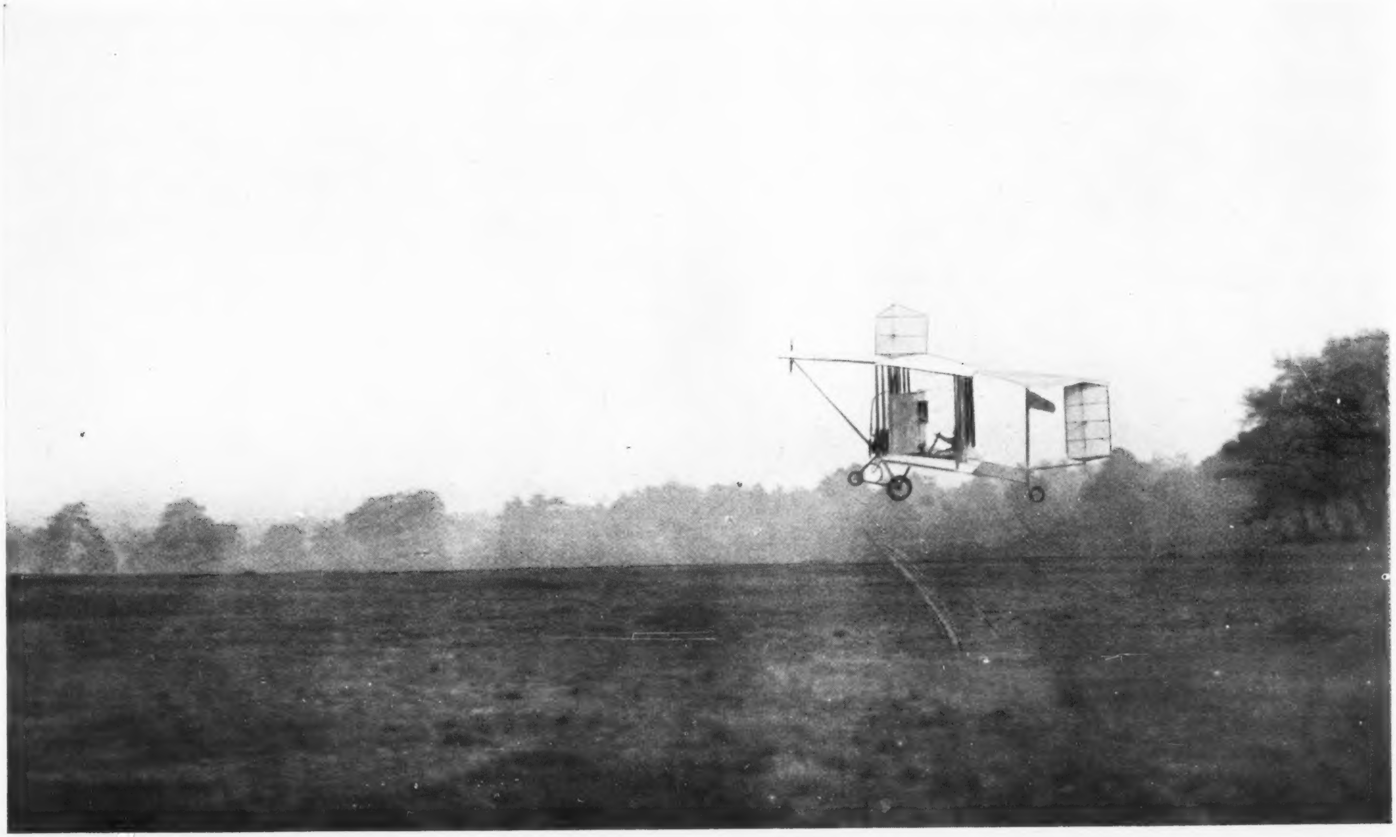


Fig. 15.—The "Cody" Power Kite.

of the obstacle. That is a point I did not think of, and had I thought of it I would have been more cautious. Now, then, I will endeavour to show you a few photographs. I have to cut what I say very short because time is going.

Photographs were then thrown on the sheet, and the following comments made by Mr. Cody:

I will start by showing you a kite. This is one of my kites. I am not sure whether the War Office officials came to see this one or not. I think not. This is the kite that was used at Bury St. Edmonds and in the North of Ireland for some time. It was 27 feet long, 16 feet wide, and 6 feet high.

This is another stamp of kite that I used shortly after I used the plain box. I have been up several times with this kite in the air 100 to 200 feet high.

There were no lifter kites used above this one. It was not very high at the time. It was simply one, and one alone.

That is another form of kite that I made. I had a good deal of experiments with it. I tried to put propellers on and drive it, you know, but it didn't seem to answer very well.

This is the present kite in its work at Aldershot with two sappers on board. These two chaps, I think, have been 800 and 900 feet high frequently. I may say that I have had as many as 27 men up in one day, one and two at a time, and up very high—up as high as 3,340 feet, and I hope to go much higher than that with my power kite. I am not going to stick near the ground. If I make only one ascent I will make it high, as soon as I get it to go. (Laughter.) But I do not term short jumping, for practice, ascending.

This is quite at 800 feet high. You will notice that the photograph is very rough. It was a very small picture, and had to be enlarged very much. This was taken at Whale Island a little over six years ago.

This is the kite and the balloon both up at the same time. You see by this that they do overlap their services one and the other.

This is a photograph taken from the kite at, I daresay, 600 feet.

This is about 1,500 feet—oh, no, more than that—taken from Long Valley. You see what I call the slabs in the camp at Aldershot, South Camp. This is that parade ground between the two rows of barracks. The old balloon factory was right here. That is a Church on the Mount, Queen's Avenue, that runs up and down there.

This is at 2,600 feet. The same camp taken from about a mile and a quarter distance. 2,600, I may say, is as high as I have been. It is not my duty to go up in the kite so much as to see that everything is right, and to teach others to go up, which I endeavour to do the best I can. (Laughter.)

This is another one taken of what is called Gun Hill, I think. The Cambridge Hospital. The clock. Here is the road that runs along the top. The blass roofs over the barracks. Here is the main road coming out of Aldershot.

The Wellington Avenue. The Cavalry Barracks. The entrance to Farnborough Road. Here is the recreation ground. The garage at Aldershot. You can see by this picture that it is quite practicable to take photographs of an enemy's position whilst passing high above him in a kite, and this is some two miles and a half from the position I am photographing.

This is the original work of the power kite or the glider which I built during my leave time and experimented with it on Jubilee Hill, Long Valley. That is the thing rolled up. It takes 20 minutes to put it together and fly it as a glider. Opening it out. Lashing it up. There was 810 sq. feet of lifting surface in this machine, and it weighed under 200 lbs. a good bit, 160 odd. That is ready for launching. The gentleman who lectured on the Wrights' machine spoke of the anemometer testing the wind. I also use an anemometer to test the wind's speed. I knew nothing about Wrights' anemometer. The Wrights claim a great invention in this twisting the surfaces. I twist the surfaces from here. This rod runs up and twists the two surfaces on this side and that side precisely in the same way demonstrated by the Brothers Wright to turn this side up and that side down. That is the position. This was done by me ever since I have flown kites. The wing of my kite is controlled in that same manner. But, of course, I have to do that or fix and adjust it from time to time, because there is nobody actually in the kite to adjust it. So it is a fixture. But when my man goes into the machine, naturally I shall do it by control, and I suppose I will be accused of having copied the Brothers Wright in time to come. I hope I will be able to prove that I do not copy them, and that I am just as much the originator of it as they are, for we both copy Nature.

That is the machine in the air. This is the knot that you should pull to adjust that. The man lying prone on to this surface here. This is the rod that I spoke of that goes up and down. You pull the surface down or pull it up at the back, and when you pull this one down that one goes up, or *vice versâ*. This is in place of the head rudder, the forward plane is apt in this machine and it pulls, like the bird's tail, the machine down or up. I don't stick to that idea always.

That is the machine set free with me in it. You will notice my big sombrero hat—that is the thing I used to wear—at that time I was a bit wild. The sappers were holding this cord, and they let go and allowed the thing to glide, and then ran ahead of it to try to keep pace with it—with about a 12-mile wind against it. It is not going quickly. I never had a sensationally quick glide anywhere. You will see the sappers running to catch it as it is gliding forward.

This is another kite. Now, the twisting of the wings is brought from these here and out at a point, and you will see in this one they are actually twisted now by this man pulling here on this point. Do you see that lifting this one up pulls that one down? The wings are actually twisted in this case, and there are several other points. This is a kite; I am just starting the engine and I am trying to get out of the way, to let it run. It was supposed to be let loose, but the authorities were afraid I might do some damage by letting it go up in the sky.

That is a form of glider, a bird-shaped thing. Mr. Weiss makes a good many of this sort of bird, but, of course, I have made them for a long time. I won't say that I am ahead of Mr. Weiss in it, but I have made them for eight or ten years. I never had any confidence in their ultimate success. They were too hard to build rigid and strong. If I build anything I do it very strong.

Now, the next article I worked on was the dirigible balloon at Aldershot; I was asked if I would take an interest in this. I did so, and helped to do what I could to make it a success. My part was the mechanical part of the balloon, and I claim to-day that it was a success in every sense of the word. I have got as much out of my Antoinette engine as any man gets to-day, either in France or in England, or anywhere else that we know of. I ran the engine 3 hours and 45 minutes, which has never been exceeded even till to-day with radiator cool. I made the Antoinette serve well, and I cannot speak too highly of it, because I like it.

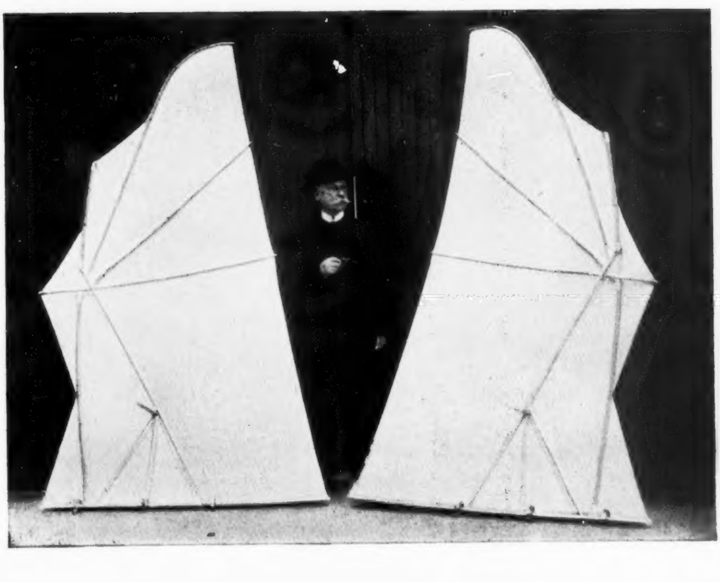
This is the balloon coming out. This is the kite wing adapted on to the balloon for making the balloon rise or fall, taking it up or down. This, the rudder, is the style of kite that I used to build when quite a boy. I was shown how to build it by a Chinaman. I was lifted from the ground by a kite when I was only 12 years old, and I have had *men* lifted by this same form of kite. It is a broadside kite, and I notice that Major Baden-Powell makes a kite something like that, though not quite that shape. I abandoned that idea of a flying machine, because the celluar type suited me better. I do not know whether I copy Mr. Lawrence Hargreaves, or whether I copy the early Chinese. I am not the inventor of the cellular type kite, but I am the improver of the system, using them and making them serviceable.

This balloon made some five voyages last year, and came to grief at the Crystal Palace, as you know, really through no fault of mine or anyone else, but the climate. And had the balloon had 100-horse power engine we would have gone home that night, I am sure, but the 50-horse power was not sufficient to drive it against the wind that was blowing, so we took the best opportunity to get down and make it as safe as we could.

This is the balloon under way exactly under the conditions that she went over London, only there were only two, Colonel Capper in the steering seat and myself at the engine. I tried my best to

Fig. 1.

Fig. 2.



make a success of it, and I hope to try many more.

This is the finished power kite ready to start. The screws are not really propellers. You may call them tractors or propellers, which you like. They are in the centre of resistance of the machine, so when I turn my machine I pivot the machine on the axis of the propeller. The propeller boss is never shifted when the machine is turning like that in the air, so in order to get any easy control, I put my screws just over the centre of lift of the machine; that is, about one-fourth of the way back from the front edge and their two sides of two propellers, and cross drive to one, the same as the Wrights', but I didn't see the Wrights' machine before I built mine. I may say it is the same drive and the same propellers as took the dirigible over London. That shows that I have done a little on my own without copying other people, and you will notice my curves are somewhat deeper than the Brothers Wright's. On the day before the accident I thought the curves were a little too deep, and I slacked out my adjusting screws in order to make the curves a little less, and the machine flew much better. On this day I went one flight about 100 feet high, and the other one about 12, and flew 100 yards each time I jumped up, but they were only jumps, as I say.

That is a machine which is running along the ground on the wheels, which were invented by, I couldn't tell you who. Sir Hiram Maxim invented one, but they were invented, I daresay, 100 years before Sir Hiram Maxim was in existence. I do not think I copied anyone in the wheel system. I did copy Sir Hiram Maxim as to placing my head rudder at the top. I considered he was sound in doing so. I want to try it in various positions in order to get the best results, and I am trying it differently next time.

This is the machine in the air. (Applause.) I sit behind. I have been very strongly criticised for sitting behind and spoiling my view. But I say if a man is a mechanic and understands his work, and is the inventor or the builder and has all his mechanical contrivances in front of him, it is best to sit where he can look at it all, and if there is a click you can stop your engine before an accident takes place. I think it is very advisable, if you know a machine, to sit where you can see it all. I do not criticise the Brothers Wright having it behind them. I prefer it in front of me at present. I have my machine constructed so that I can put my propellers at the back, at the middle, or in the front, and I mean to do it all if my machine lasts long enough. And in that case I will sit in front if I put my propellers at the back, and the two passengers I hope to carry will sit just behind me, all in the centre, not abreast, but all in a line one above the other. The second man, that is, the man behind me, will look over my head, and the man behind him will look over his head, and see everything that is going on and still not be in the way of the machinery or be exposed to the air pressure. I have it fixed so that I can close the engine-room in and get no wind on any obstacle in their sight. The driver will be sitting in front, thus reducing the head resistance with the passengers directly behind him. (Applause.)

The President: The Chinese have shown the world the fascinating beauties of the kite, but I think Mr. Cody's kite is even more interesting, and we owe him our thanks for the excellent paper he has read to us. Now, we have just a few moments for Mr. Page to give his report, and then I must close the meeting.

Mr. Handley Page submitted the Report of the Wings Committee, by Major Moore, R.E., and himself. Photographs of the diagrams, etc., were shown on the sheet.

The Aëronautical Society of Great Britain Wings Committee.

By MAJOR MOORE (Late R.E.), and S. H. PAGE.

EXPERIMENTS WITH FLAPPING WINGS.

I.—Apparatus Used.

Wings.—The wings were modelled on the lines of the wings of a flying fox, the general appearance being as shown in Figs. 1 and 2.

The dimensions of the various members are given in Fig. 3.

The main part of the frame was made of $\frac{1}{16}''$ gauge steel tube of the following diameters:

Hinge arm $\frac{5}{8}''$
Main bow $\frac{1}{2}''$ with $\frac{5}{8}''$ cover at centre.
Main arm $1''$ T-iron of $\frac{3}{16}''$ gauge.

Bamboos were used for the stiffening cross pieces, and varied in size from $\frac{3}{4}''$ to $\frac{1}{2}''$ in. diameter.

The framework was covered with canvas balloon material.

being driven by belting from the main gas engine shaft.

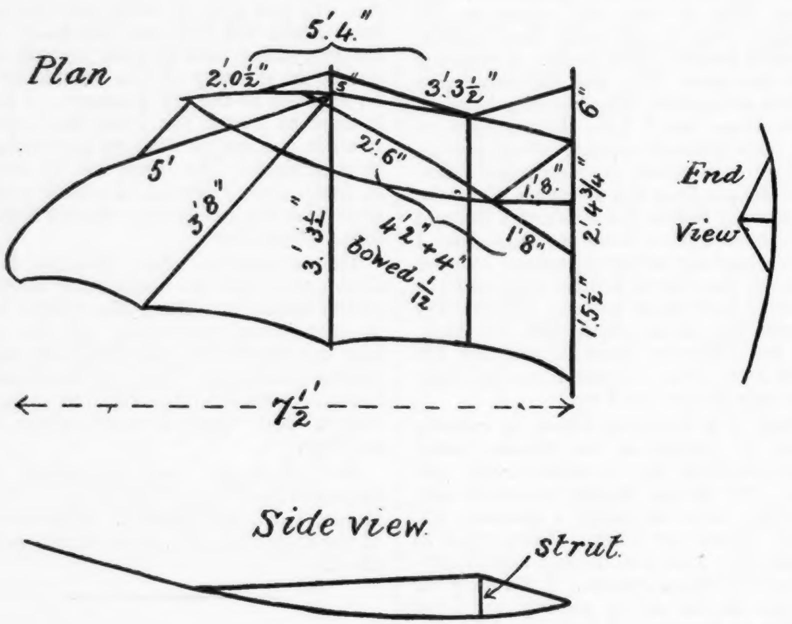
The frame was divided into two parts—the lower part was fixed on the ground, and the upper was free to move round the driving shaft.

A rope attached to the frame prevented the framing falling back, and a spring balance on the wire at the back measured the actual pull when the wings were flapped.

II.—Experiments.

The experiments were divided into two

Fig. 3.



Each wing had an area of 22½ square feet and weighed 10 lbs., or a total area of 45 square feet, and weight of 20 lbs. for the pair.

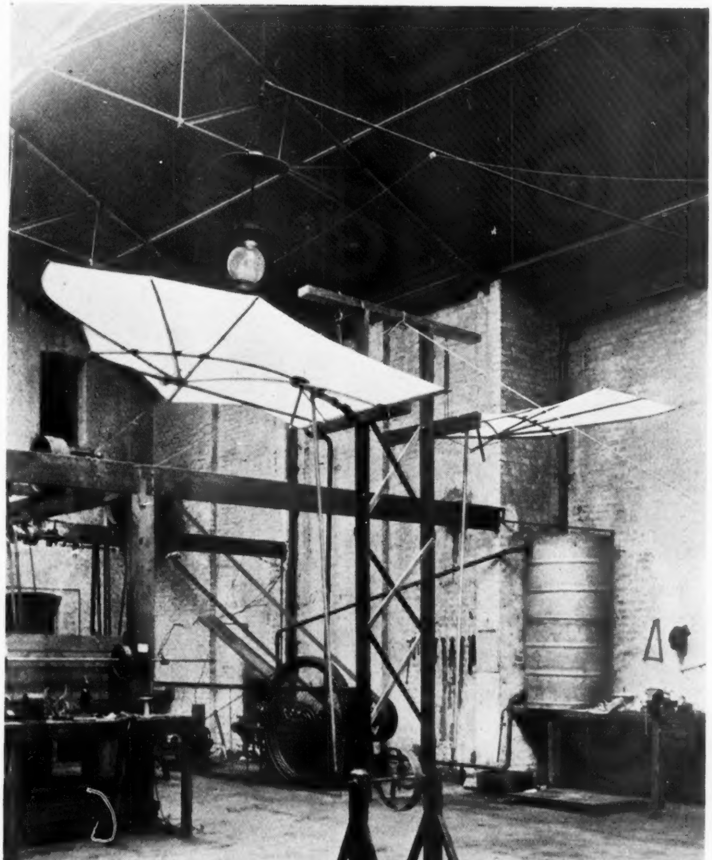
Testing Framework.—The photograph in Fig. 4 gives a good idea of the general appearance of the testing arrangement.

The wings were hinged to the cross pieces fixed to the upper part of the framework, and the necessary flapping motion was obtained by a crank and connecting rod system fixed on the shaft in the lower part of the apparatus, this shaft

sets—the first series to obtain some working data of the forward thrust with a given H.P., and the number of strokes per minute. The second to test the combined arrangement of springs and wings in imitation of pectoral muscles as in Nature.

First Series.—The wings were fixed with the concave side downwards, and flapped at different speeds. Readings were taken of the horizontal thrust, the strokes per minute, and the H.P. absorbed.

Fig. 4.



The following readings were obtained:

Strokes per minute.	Thrust in lbs.	H. P. absorbed.
60 ...	... 6	.. .13
80 ...	... 10 to 12	3
100 ...	... 16 to 24	... .59
120 ...	... 24 to 27	... 1.02 to 1.4

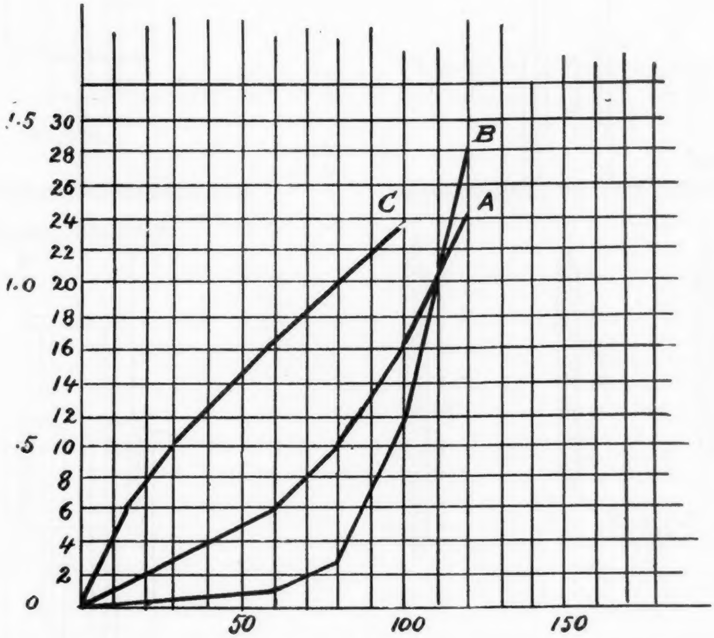
In Fig. 5 these readings have been plotted in curves, "A" showing the relation between thrust and strokes per minute; "B" the H.P. absorbed at different speeds; "C" the H.P. absorbed for various values of the horizontal thrust.

to the cranks, and an upward pull by means of the springs (described above).

At every stroke the wings rose and fell with the quick movement necessary to imitate the action as in Nature.

The wings were also flapped with the framework fitted as in the first series of experiments, having their concave side down. They raised the whole of the upper framing, weighing 33⅓ lbs., each stroke showing that a lifting as well as a propulsive force is obtained with the wings.

Fig 5.



In the experiment the weight of the wings was supported by spiral springs, as shown in Fig. 6, attached to the framing.

The springs used were 8″ long in the body, 1¼″ external diameter with 6 coils to the inch. They stretched from 8″ to 10″ when loaded with 70 lbs., and had a period of 120 per minute (see Fig. 8).

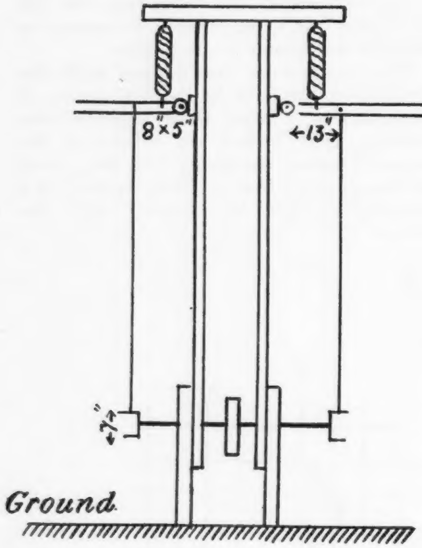
Second Series.—The wings were turned on their backs and given a downward pull by means of a wire (instead of a rod as shown in the photo Fig. 6) connected

To test the mechanical action without having the interference of the surface of the wings acting on the air, plain arms were arranged as shown in the diagram Fig. 7.

A dead load was hung on the framing to strain the springs in addition to that of the framing.

Load—frame ...	...	38
wheel and axle		33
added load	...	150-221 lbs.

Fig. 6.



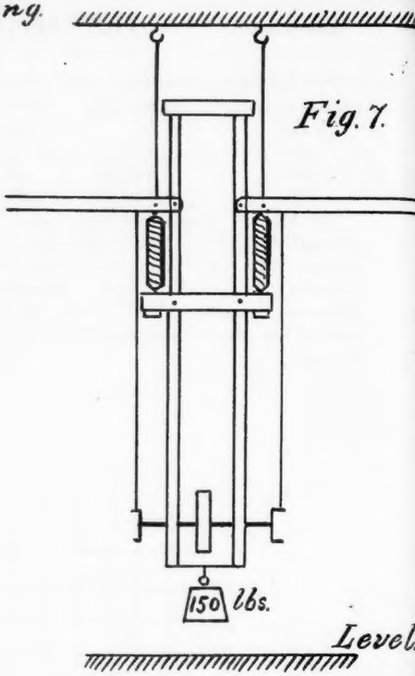


Fig. 7.

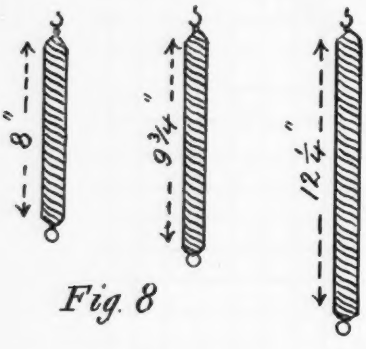


Fig. 8

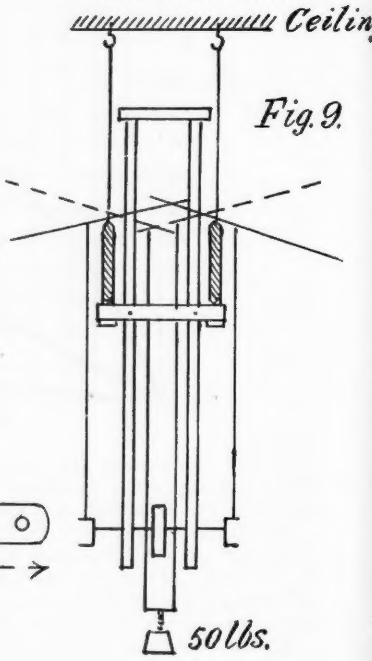
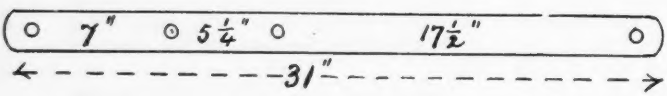


Fig. 9.

Fig. 10



Springs under strain:

lowest position of crank, see "B" Fig.
highest do. see "C" Fig.

Number of strokes per minute ... 112

Lift of load ... ... 3″ to 3½″

Work = 221 lbs. × ¼′ × 112 = 6,188 ft.-lbs. = $\frac{1}{5}$ H.P. approx.

Again, to see how the plain arms would act with leverage and a reduced load, instead of a dead load only (the arrangement shown in diagram Fig. 9), was tried and was found to work satisfactorily.

This last experiment is an imitation of the pectoral muscles as they act in Nature.

III.—Conclusion.

The first series of experiments shows conclusively that

(1) With properly constructed wings a forward and upward thrust is obtained.

(2) The thrust varies as the square of the velocity of the wing tip on its upward and downward stroke.

(3) The H.P. absorbed varies as the cube of the same velocity.

The second series of experiments:

(1) Wings can be made to flap as in Nature, by using springs in the place of the pectoral muscles, these springs being selected for correct amplitude, period, and strength.

REMARKS BY MAJOR R. F. MOORE.

The experiments with flapping wings show that a horizontal thrust of from 20 to 27 lbs. per H.P. can be obtained. This is far in excess of the 6 to 7 lbs. that Mr. Wilbur Wright obtains with his propeller. A machine constructed with flapping wings as in Nature would be a true flyer and be far superior to any "Power Kite" or "Power Gas Bag" for aërial flight. It would be more independent of the state of the weather, would be more self-contained, and travel at a greater speed.

This can be best proved by constructing a full-sized machine, for which money and means are required.

The President: We are very pleased, indeed, to have the Report so ably put before us by Mr. Page. With these few words I will close the meeting.

Major Baden-Powell: Ladies and Gentlemen,—I am sure we cannot close this meeting without thanking our President, Mr. Frost, for so ably taking the chair to-night. I hope you will agree with me in according your thanks to him. (Applause.)

Colonel Francis C. Trollope seconded the vote of thanks, which was unanimously adopted.

The President: I am very much obliged to you, ladies and gentlemen. I do not think much of the figure-head as a rule, but I should like to pass your thanks on, if you will kindly allow me to do so, to our energetic Honorary Secretary, Colonel Fullerton. (Applause.)

On the Action of Aërial Propellers and Aeroplanes.

By H. C. VOGT, C.E.

During the years 1883-1886 different launches here were driven by aërial propellers or revolving sails, and the intention was a simultaneous utilisation of wind and steam power, nearly 80 per cent. of the wind directions being utilised, when sailing in a circular course. It was found that the efficiency of an aërial propeller, when correctly constructed, is a trifle superior (on account of the elasticity of the air) to that of a water propeller; at present, therefore, where the aërial propeller has come into practical use for driving aëroplanes its theory may perhaps attract attention.

Experiments prove that its thrust is mainly derived from the rarefaction created on the leeward or suction side of its wings, and the manner of showing this was mentioned 19-20 years ago in *Engineering* and other journals; the apparatus used was the following: The deceased Captain Rúng, of the Danish Artillery, had constructed an apparatus consisting of two tubes, *t* and *u*, perpendicular to and in communication with one another, *u* forming the axle for *t*, and *u* communicated with a manometer. When *u* revolved upon its own axis (swinging it round), the air was rarefied in *t*, which was open at its outer end. The rarefaction followed the law expressed by the formula for the centrifugal force, $r\ m\ w^2$; r is the length of the tube t; w its angular velocity; m the mass of the air in t. The rarefaction is, however, quite independent of the diameter of the tube t; it is better, therefore, to write the formula: $k\ r\ w^2$, where k is a coefficient, and the rarefaction at a certain distance from u only depends on r and w.

We borrowed Captain Rúng's apparatus; t was made 20.5 cm., or about 8.1 inches, long, and its outer end was shut, and two holes were bored through its shell 20 cm. and 10 cm. from u. When these holes were kept directly on the lee side of t, when it was swinging at the rate of 20 revolutions per sec., the manometer indicated a rarefaction corresponding to a lift of 66 mm., or 2.6 inches, of water at the outer hole, 20 cm. from u, and 32 mm. at the inner hole, 10 cm. from u (one hole being shut when the other was examined). When the tube t was turned 180° so as to have its holes directly to windward, then, when swinging at 20 revolutions per sec., the wind pressure on the tube t would nearly counteract the rarefaction. At high rates of revolution the pressure on the windward side of t is scarcely able to counteract the rarefaction due to centrifugal force. When t was turned, so that the holes were just a little abaft the side of t, then the air, in rushing over the holes, when t was swinging, produced suction and slightly augmented the rarefaction.

A plate, 9.4 inches long by 3 inches wide was now fastened lengthwise, and along its middle line to t (the middle of its short side was supported on u), and this plate formed an angle of 45° with a plane perpendicular to u; 2 holes 20 cm. and 10 cm. from u were then bored through the plate and through the shell of t, and tightness was secured by means of soldering. The rarefaction must be examined direct on the surface of the plate, therefore no other method of experimenting can be used. (As explained, the rarefaction, or in water the diminution of pressure, depends upon r, the distance from the axis of u, and upon w the angular velocity.) This plate was now, as before, swinging at the rate of 20 revolutions per sec., and the holes were kept on the leeward side of the plate. The rarefaction on the plate 20 cm. from u (the tubular axle) now amounted to a lift of 70 cm., or about 2.8 inches of water, and 10 cm. from u it was 33 cm. The rush of air passing by the leading edge of the plate sucked the air from its lee side, and thus augmented the rarefaction. (Nearer the leading edge of the plate the rarefaction would have been still stronger, and farther away it would have been less.)

The mass of air striking the windward side of the plate is $9\,m\,A\,V^2 \sin' a$, m = mass of unit volume, A the area of the surface struck, V, the velocity of the fluid striking, is proportional to the distance from u, a is the angle of incidence, in this case 45° (this formula has been demonstrated so often that it is unneedful to reproduce it here). The pressure corresponding with the impact of this mass of air is, at 20 revolutions per sec., sufficient to counteract the rarefaction, which is also produced on the windward side of the plate when rotated as here; this was proved by turning t with the plate attached at an angle of 180°. In order to avoid the projection of t on the one side of the plate, a flat hollow body with holes on its surface, and communicating with u may likewise be used, but this does not make any appreciable difference in the results as long as r and w, etc., remain the same. These experiments, undertaken about 22 years ago, and performed merely for the sake of proving the existence of this diminution of pressure on the one side of the propeller surface, do not therefore lay claim to scientific accuracy. When a propeller is at rest the pressure H, due to the air column (also water column), acting on both sides of its blades, is the same; and when it is towed, revolving freely, nearly the same, only the suction-side is changed into the thrust side; but when a propeller blade begins to revolve under the action of the engine—obtaining a proper speed V, in its point of effort, then this speed V corresponds to a pressure-height $h = \frac{V^2}{2g}$, so that the pressure on the suction-side becomes a function of $H - h$, and on the thrust side a function of $H + h$. It is by means of the suction-centre $H - h$ that the fluid in front of the propeller is drawn upon—even miles in front of the propeller when powerful.

In *Engineering* for July 10, Mr.

Phillips has given a beautiful illustration and one which is perfectly correct, of the stream lines in air moving towards a propeller, it is, however, only a part—often a small part—of the fluid acted on which passes through a propeller. The following experiment proves that: If the resistance is measured behind a screw-propeller working behind a launch or ship with a full stern, and consequently with considerable wake and following currents, then this resistance is found to be less than at the side of the launch. This shows that the race produced by the screw is fully taken up by the wake. In fact, the water behind the screw possesses in this case speed in the direction of the ship. The real momentum where the water possesses speed in opposite directions to that of the ship, and thus able to overcome its resistance, is formed in front of the ship.

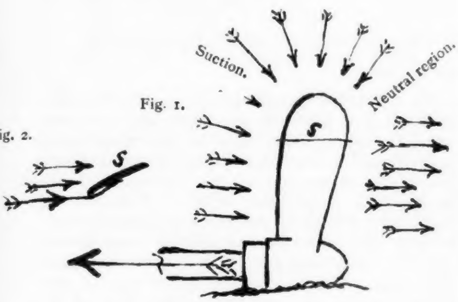


Fig. 1. Fig. 2.

Let Fig. 1 indicate a right-handed propeller-blade moving in the direction of the big arrow, and some of the stream lines converging in the same—even partly from behind—are indicated by the small arrows. With an apology for using a metaphor, let us now imagine these stream lines to be filled with small aërial sportsmen, possessing both weight and inertia, and counteracting gravity and moving swiftly in any direction by means of certain electric currents in their legs and arms. They are, however, very obedient, and have strict orders from their governor to follow the stream lines and to try, if possible, to cover the leeward or suction-side of the revolving propeller-blade, which is furnished with numerous small handles. Now it will be seen from the formula $k\ r\ w^2$, that near the boss of the blade, the small beings are able to rush in and hold on for a little while, but on moving further out on the blade they loose their hold and fly out, producing a real current; from outside, however, as shown on the stream lines, the small aërial beings rush in, attempting to fill up the vacant places, whereat a resultant current is set up, which sends them out in the opposite direction to that of the propeller. But, when the small beings cannot keep their places even by means of the handles, a rarefaction is the result. On the thrust side of the blade the small beings are pressed down in an opposite direction to the motion of the propeller, and they cannot fly out on account of the pressure of the myriads of beings behind them; on that side there is, however, a tendency to move inwards from the higher pressure near the tips to the lower round the boss.

In case of negative slip, where the speed of the propeller is greater than that which corresponds to its revolution and pitch, the small beings acquire, as it were, a greater facility for striking the suction side. Still they cannot keep their hold. Centrifugal force is too strong, and a diminution of pressure is and must be created notwithstanding the negative slip. There is suction on both sides of the propeller-blade, so that the propeller does not act economically; the diminution of pressure is, however, many times greater on the real suction side of the blade than on its thrust side. The stream lines have, in case of negative slip, to bend round the leading edge and then to close in upon the thrust side of the blade, as shown on Fig. 2.

Even when the notion "slip" is introduced, the old corkscrew theory does not hold. Just after having experimented with aërial propellers we experimented for several years with sail systems on a yacht of 3½ tons displacement; the resistance of same under different angles of keel and leeway was ascertained by means of towing experiments. The normal thrust on the sails resulting from the air striking the windward side was, as before mentioned, $9\ m\ A\ V^2 \sin^2 \alpha$ and this part amounted under close headed sailing to only 5 to 6 per cent. of the whole thrust, or nearly 95 per cent. of the thrust of the sail results from the rarefaction. The rarefaction on a swan's wing represents about 98 per cent. of the thrust of the wing; the air-current passing the leading edge or fore-arm of the wing draws—by its friction—the air from its top-side, thus creating (in connection with centrifugal force) the rarefaction; the air-current is, however, thereby itself deviated and sent out in opposite direction to that of the bird, thus forming part of the momentum to lift and drive same. In like manner, the rarefaction formed on the leeward side of sails and aëroplanes creates the momentum, whereby the ship is driven, and whereby the aëroplane is lifted, only when $\alpha = 90$ in the above formula half of the thrust of the sail results from direct impact and half from the rarefaction; the coefficient 9 in that case is about 0·45. The formula published nearly 20 years ago in *Engineering*, *Steamship*, and other journals, resulting from these experiments was $T_\alpha = 9\ m\ A\ V^2 \sin^2 \alpha + A$ where A represents the rarefaction, T_α = the normal thrust on the sail. A practical formula for T_α is: $T_\alpha = 9 \sin \alpha\ T_1$ where 9, for small values of α (5-8 degrees) is about 3; for $\alpha = 30°$, $9 = 2{\cdot}2$. *i.e.*, the normal thrust for $\alpha = 30$ (remembering that $\sin 30° = \frac{1}{2}$) is greater than for $\alpha = 90°$. These experiments with sail systems were afterwards continued on the gunboat *Hauch*, commanded by Captain Trolle, Royal Danish Navy, and published in *Steamship* November, 1894, and April, 1895.

In order to have more accurate experiments we laid the whole of this aërodynamical matter before Mr. Irminger, Director of a Gasworks, where the necessary appliances were at hand; being an excellent experimenter, we asked him to undertake experiments as regards the exact value of the rarefaction on the leeward side of a surface under different angles of incidence, and to this he consented. Hollow flat bodies, with holes on their surface, communicating with a manometer were used as formerly. Mr. Irminger arranged all these experiments beautifully, and extended the same to structures and buildings. The experiments were published in *Engineering*, December 27, 1895. The National Physical Laboratory has, however, also undertaken similar experiments, and proved the existence of the above rarefaction. The formula $T_\alpha = 9\ m\ A\ V^2 \sin^2 \alpha + A$ was fully corroborated (until $\alpha = 30°$, 9 is about 0.9, and between 30°-90° 9 is about $\frac{1}{2}$).

In a letter to *Engineering* of June 19, 1908, it was shown how birds and flying machines must work, under the law of corresponding speeds, in order to work with maximum efficiency and economically; it was further touched upon how the strong wind differences below the Capes of Good Hope and Horn enables the albatross to move with motionless wings.

In a letter to *Engineering* of September 25, 1908, it was proved why the wing possesses higher efficiency than the screw-propeller. It now remains more fully to show how aëroplanes might use the wind differences.

Osterbrogade, 108,
Copenhagen,
December 26, 1908.

To Colonel J. D. Fullerton, R.E.

Dear Sir,

In my letter to *Engineering* of June 19, 1908, it was pointed out that the albatross used the great differences in the wind energies (found below the Capes of Good Hope and Horn on account of the big waves there) to fly with motionless wings. This fact is easily understood by referring to another fact, namely this: The bob or ball of a pendulum set free at a certain altitude cannot regain the same altitude—at the other end of the swing—unless an extra push be given to it! Now, consider an albatross weighing 23 lbs. at a height of 60 ft. above the sea level (it seldom comes higher), and, say, the wind there has a speed of 36 ft. per sec., and 10 ft. over the wave tops it is, say, 20 ft. per sec., and in the wave troughs it is 0.

If, now, the albatross has a proper speed of, say, 35 ft. per sec. left in relation to the sea and at the said altitude of 60 ft., then, when coming from the lower wind velocities, it is just able to push itself against the said wind of 36 ft. per sec., by means of the energy $\frac{1}{2}\ m\ V^2 = \frac{1}{2}\ \frac{23}{g}\ (35)^2$ contained in its body and keep itself suspended for a moment, but now it turns and descends, say, 50 ft., but on an inclined course, say, 150 ft. long. The corresponding final speed would in a vacuum be $\sqrt{2g \cdot 50} = 57$ per sec., and the corresponding energy $\frac{1}{2}\ \frac{23}{g}\ (57)^2 = 1{,}160$ foot-pounds. But the albatross's resistance is about 2.3 lb., whereat $150 \times 2.3 = 345$ foot-pounds will be consumed, leaving $1{,}160 - 345 = 815$ foot-pounds corresponding to a final speed of 48 ft. per sec. That would not nearly be sufficient again to raise it to an altitude of 60 ft., which, along the lower course—150 ft. long—would require: $150 \times 2.3 \times 23 \times 50 +$ the energy corresponding to a final proper speed of 35 ft. per sec., which is $\frac{1}{2}\frac{23}{g}(35)^2 =$ 439 foot-pounds, making the aggregate amount 1,925 foot-pounds. But, when the albatross from its altitude of 60 ft. takes a short turn with the wind, its proper speed of 35 ft. per sec. can not only be maintained, but it can easily be increased, say, to 42 ft. per sec., which would increase the above speed—48 ft. per sec.—to 90 ft. per sec., making the energy, at the end of the descent, $\frac{1}{2}\frac{23}{g}90^2 = 2{,}835$. Subtracting the above energy, 1,925 foot-pounds, necessary to raise it to 60 ft. above the sea level, thus 910 foot-pounds remain, sufficient for a sweep of 395 feet.

Besides these extraordinary wind differences, there are the ordinary, where the wind energies from second to second easily may vary 50 per cent. even 100 per cent. (because the energy contained in the wind varies with the third power of its speed), when the wind is strong the bird rises, when weak it descends.

The above is only a very rough sketch in order to point out the possibility of moving with motionless wings. A scientific treatment of the matter would carry us very far.

I am, Sir, yours faithfully,

H. C. VOGT.

REVIEWS.

"Artificial and Natural Flight." By Sir Hiram Maxim, Member of Council, the Aëronautical Society of Great Britain. Whittaker and Co.: pp. 166, with 95 illustrations.

This little book by Sir Hiram Maxim will be read with much interest, as it gives a very full account of the experiments made by him at various times, and explains them in very simple language.

Commencing with some general introductory remarks on the necessity for actual experiment in aëronautical work, the author then describes his observations on air currents and the flight of birds; explaining how the constant interchange of cold and warm air takes place, and pointing out how the rising currents of air assist the soaring birds.

Chapter III. discusses the action of kites, and explains the effect of the wind upon them.

In Chapter IV., one of the most valuable and interesting in the book, the design of screw propellers is examined, and some very important results regarding the skin friction, which Sir Hiram considers to be very small indeed in a well-made screw, are given. What will, however, most interest our readers is the detailed results given of the lift and drift of certain bodies and surfaces described in pp. 54, 55, etc. It is clear from these experiments that the *form* of aërosurfaces, bodies, etc., is of immense importance, as well designed fair shapes very largely reduce the resistance to forward motion, while they have at the same time considerable lifting power. The account of the experiments with Phillips' type surfaces to show the power of the air for condensing is interesting, and brings out the importance of so arranging the surfaces, that the air which has once struck a heated surface does not come in contact with another warm area.

Chapter V. gives a full account, with excellent sketches, of Sir Hiram's whirling machine, and describes in some detail the method of using it, the Crystal Palace experiments being specially interesting, owing to the high velocity (some 80 miles per hour) attained.

A design for a flying machine something of the Wright type is given in Chapter VI., and the information regarding the forms of aërosurfaces, struts, ties, etc., will be found very useful by those who wish to construct their own machines.

The action of the gyroscope as employed by Sir Hiram at Baldwyn's Park is discussed, and the chapter closes with some excellent diagrams explaining the design of the large machine tested in 1895.

In Chapter VII. some of the recent machines such as the Farman, Blériot, etc., are described, while in chapter VIII. the difficulty in constructing effective balloons is explained.

Appendix II. gives a useful summary of Sir Hiram's experiments, and discusses various points in connection with motors, efficiency of screw propellers, etc.

The book is well illustrated, and contains a great deal of very useful information.

"A Manual of Oil Motors and Their Uses." By G. Lieckfeld, C.E. (Sole authorised English edition.) Charles Griffin and Co., Ltd.

This work is a translation of the third edition of "Die Petroleum und Benzinmotoren," a well-known German handbook on liquid fuel motors.

CHAPTERS I. and II. contain a brief account of the origin, etc., of liquid fuels, and their qualities for power production.

CHAPTER III. traces the development of the petrol and paraffin motor, describing briefly the principles of the Brayton, Daimler, Capitaine, and other motors. The chapter concludes with a short account of the first "Diesel" engine, the more detailed description being reserved for chapter VII.

In CHAPTER IV., the construction of this class of engine is considered, and the various component parts, such as the frame, piston, carburettor, fuel pumps, and starting devices are clearly described.

CHAPTER V. gives an account of various ignition systems, while CHAPTERS VI. and VII. give detailed designs of a number of different stationary petrol and alcohol engines.

CHAPTERS VIII. and IX. are the most interesting ones for aëronauts, as very full descriptions of different kinds of motors more or less suitable for aëronautical work are given. The illustrations in this chapter are excellent, and the construction of the types selected is clearly shown.

CHAPTER IX. deals with ship, boat, and airship engines, the Körting and Antoinette types being briefly noted.

CHAPTER X. gives an account of various motors used for vehicles and airships. The work of Renard, Lilienthal, etc., is briefly alluded to (though no mention is made of Lilienthal's carbonic acid gas motor), and outline diagrams of the "Zeppelin" and "Ville de Paris" balloons are given.

The last chapter contains useful hints on the erection and attendance of engines driven with liquid fuel, and the book closes with a good index.

The illustrations are clear and well drawn.

"THE WINDS THAT BLOW." By Gerrard H. Hickson, 3, Hyde Avenue, Leeds.

This is a small four-page pamphlet, describing the author's theory of the causes of wind, of its varying volume, force, velocity, temperature, and direction. In it he explains how the air moves, the reasons for such movement, and how it is possible to predict the occurrence of any given wind or storm with greater accuracy than has hitherto been possible.

In such a small pamphlet, of course, only a general outline of the author's theory can be given, but the ideas seem to be worthy of consideration, and the book which Mr. Hickson proposes to publish later on will probably be found of interest.

"AERODONETICS." By F. W. Lanchester. Constable and Co. (Vol. II. of "Aërial Flight").

This is the second volume of Mr. Lanchester's work, and it is not too much to say that it is quite as interesting as the first one.

CHAPTER I. discusses the general principles and phenomena of free flight, and explains the use of the simplest form of ballasted aëroplane used by the author. Some other forms of gliders, etc., are described, but the main interest of the chapter centres in the different experiments carried out by Mr. Lanchester himself during 1894. The work done by him is fully discussed, and the chapter ends with a general summary of the results obtained.

CHAPTER II. explains the author's views concerning the equation of flight path. The discussion is purely theoretical, and the student should take special note of the assumptions made in par. 19.

CHAPTER III. describes a particular method of plotting the phugoid equation, as this equation does not lend itself to the ordinary methods. Numerical examples are given, and a system of working out phugoid charts described.

In CHAPTER IV. the elementary results of the phugoid theory are discussed, viz.: stability in the face of a disturbing cause, the "Index of Stability," wind fluctuations, their effect on stability, etc.

CHAPTER V. is the most important in the book, as it enters fully upon the question of stability as affected by resistance and moment of inertia. After due consideration of the different points, an "equation of stability" is given, which shows that a certain function called the "coefficient of stability" must, for safety, be greater than unity.

The reader should carefully analyse this equation, as from it the influence of the different *parts* of a machine can be deduced. For instance, an increase of l or a (see par. 61) means an increase of stability, while, on the other hand, if K is reduced, the value of the stability coefficient is decreased.

CHAPTER VI. describes experimental work done by the author and others, verifying his theoretically deduced conclusions. Clearly worked out numerical examples show the application of the "equation of stability" to the author's models, and in the latter part of the chapter similar calculations are made for birds and the Lilienthal machine, with very fair success.

In CHAPTER VII. lateral and directional stability are considered, the difference between the two being clearly explained in par. 83; while CHAPTER VIII. contains a general summary of the conclusions arrived at in the first half of the book. This summary is very interesting, and it is most satisfactory to see that the author thoroughly understands that (see par. 139) " the longitudinal stability of an aërodone is determined by purely dynamical considerations, without any adjustable organs or mechanism whatever."

In CHAPTER IX. " Soaring " is discussed, and the various theories on this subject propounded by Froude, Lord Rayleigh, Roy, Mouillard, Langley, and others are explained. An interesting feature is a description of Bazin's " Montagnes Russes," or switchback for showing the action of the soaring birds. The author, quite independently of Bazin, worked out a similar apparatus in 1894, and exhibited it at the Birmingham Natural History and Philosophical Society. Fig. 120 shows his design, and a full description of the method of working it is given in par. 153.

CHAPTER X., on Experimental Aërodonetics, will specially appeal to readers who are unable to follow the more theoretical portion of the book, as a full explanation is given of the method of construction of the aërodones employed by Mr. Lanchester, with details regarding materials, etc.

The volume concludes with appendices describing the author's aërodone of 1894, a practical method of finding the moment of inertia of a model, and notes on the gyroscope, boomerang, etc.

Like Vol. I., the book is well and clearly illustrated, and forms a very interesting exposition of the principles of " Aërial Flight."

Foreign Aëronautical Publications.

(In this list a selection of some of the more notable articles only is given.)

AERONAUTICS (AMERICA).

October, 1908.—Death of Lieut. Selfridge.—On the Gyroscopic Action of Propellers.—The Wright Aëroplane.—Some Construction Details of the Wright Aëroplane.—The Berliner Helicoptere.—Evolution of the "Two Surface" Machine (Chanute).—Principles Involved in the Formation of Wing Surfaces,

November, 1908.—The " Herring Aëroplane." —First Exhibition and Tournament of the Aëronautic Society.—Principles Involved in the Formation of Wing Surfaces.

L'AEROPHILE.

October 1st, 1908.—The German Military Balloons.—The Marvels of Aviation (account of the Wright Bros.' experiments).—Physiological Researches in Balloons.—The Malecot Airship.

October 15th, 1908.—The Progress of Wilbur Wright.—Splendid Flights by Henry Farman.—The Fruth " Grand Prix."—Blériot VIII.

November 1st, 1908.—The "Gordon-Bennett" Cup, 1908.—The Work of the Brothers Wright. —Dirigible Balloons.—Aëroplanes in France.

November 15th, 1908.—The Banquet to Wilbur Wright.—On Sailing Flight.—The Trials of the Clement-Bayard.—The German Dirigibles.—Marvels of Aviation.—The Experiments of Mons. Blériot.—The "Gordon-Bennett" Cup, 1908.

December 1st, 1908.—A description of the Wright Aëroplane.—Aviation in France.—The French Dirigibles.—The Italian Dirigible.—The Co-efficient " K."

December 15th, 1908.—Sailing Flight (Josè Weiss).—A New Method of Generating Hydrogen.—The Theories of Mons. Deprez—Aëriation in France.

LA REVUE DE L'AVIATION.

October 15th, 1908.—On the Useful Weight of Aëroplanes.—" Wilbur Wright, Record Man."—Elements of Aviation (Victor Tatin).—Farman at Chalons.—On the Tractive Effort of Aëroplanes.

November 15th, 1908.—The Aëroplane in War.—The Future of Aviation in the Navy — Farman Triumphs.—The Cellular Blériot.—The Sustaining Plane of an Aëroplane (Extracts from Mr. Turnbull's Paper).—The Evolution of the " Biplan " (Chainte).

SOCIETA AERONAUTICA ITALIANA.

No. 10.—On the Construction of Sheds for Dirigibles.—The Winds in Italy.—Aëronautical Notes —Scientific Notes (Aëro-Dynamic Experiments by Goupil, from the Bulletin Technologique, May, 1908. On the True Velocity of Dirigibles).

ILLUSTRIESTE AERONAUTISCHE MITTEILUNGLU.

October 7th, 1908. — The Gordon-Bennett Race.—The Freedom of the Air.—The "Cognac's" Journey to Italy.—Short Notices.

October 21st, 1908.—The International Flight Competition in Berlin.—" Weather Charts" —Vacuum Airships—The Italian Military Airship.

November 4th, 1908.—On the Radius of Action of Airships.—The New Period in American Airship Construction.—Short Notices.—The Third Zeppelin Model, *November 18th, 1908.*—Theoretical Criticisms of the Wright Flying Machine.—Elementary Statement of the Conditions of Aërodynamic Flight.—The Russian Military Airship.—The "Clement-Bayard."

WIENER LUFTSCHIFFER ZEITUNG.

October, 1908.—At Issy and Auvours—Orville Wright at Fort Myers.—The Dirigibles at Berlin.—The Gordon-Bennett Race.—On Sailing Flight.

November, 1908.—The Gordon-Bennett Race. Count Zeppelin.—About Wilbur Wright.—The Wels-Etrich Experiments. — The Parseval Balloon.

December, 1908.—The Gordon-Bennett Competition.—From England to Russia.—Count Zeppelin. — The Stranding of the German Military Airships.

Applications for Patents.

(*Made in September, October, November, and December.*)

The following list of Applications for Patents connected with Aëronautics has been specially compiled for the AËRONAUTICAL JOURNAL by Messrs. BROMHEAD & Co., Patent Agents, 33, Cannon Street, London, E.C.

SEPTEMBER.

20433. September 29th. A. R. SILVERTON. Improvements in airships.

20489. September 29th. A. HALLEUX. Improvements in flying machines.

20530. September 30th. W. GWINNETT. Pneumatic armour for use on aeroplanes and the like.

OCTOBER.

20694. October 1st. A. F. J. DOUTRE. Improvements in flying machines and aeroplanes.

20785. October 2nd. L. BLERIOT. Improvements in or relating to aeroplanes and the like.

20822. October 2nd. E. SCHMID and H. BAUER. Improved motor vehicle adapted for use as a flying machine and for other purposes.

20892. October 3rd. R. HUBBARD and A. HENRY. Improvements in dirigible balloons.

21031. October 6th. H. LEDWARD. Means for imparting stability to or improving the stability of aeroplanes, balloons, and other machines for aerial navigation.

21074. October 6th. J. E. HUMPHREYS. Improvements in aeroplanes.

21092. October 6th. A. TREBELHORN. Improvements in airships.

21261. October 8th. J. R. PORTER. Improvements in and relating to airships.

21363. October 9th. W. E. EVANS. Improvements relating to rudders for airships.

21411. October 10th. J. T. PICKERSGILL. Improvements appertaining to aeroplanes or like flying machines.

21445. October 10th. P. F. DEGN. Improvements in flying machines.

21461. October 10th. W. D. JONES. Improvements in motor-operated aerial machines.

21469. October 10th. C. A. CHAPPELL. Improvements in aeroplanes for toy or amusement purposes and for scientific uses.

21488. October 10th. F. MACPHERSON and J. MCHARDY. Improvements in aeroplanes.

21491. October 10th. E. M. ELLISON. Improved airship.

21498. October 10th. R. PENKALA and E. PENKALA Apparatus for rising and travelling in the air or for travelling in the water.

21618. October 12th. J. DONOVAN. Improvement in the mode of an apparatus for flying.

21656. October 13th. R. THAYER. Improvements in airships.

21668. October 13th. W. F. HOWARD. Improvements in aeroplanes.

21883. October 16th. J. P. GLOVER. Airship.

21952. October 16th. W. BRITAIN. Improvements in flying machines.

22061. October 19th. J. WESTAWAY. Improvements in and connected with aeronautical machines.

22062. October 19th. J. WESTAWAY. Improvements in or relating to aeronautical machines.

22099. October 19th. M. ARTIA. Improvements in flying machines.

22125. October 19th. L. V. FEUILLET. Improved dirigible balloon.

22209. October 20th. W. MARK, JUN. Improvements in apparatus and appliances for raising, lowering and propelling airships, flying machines, and the like.

22238. October 20th. J. E. HUMPHREYS. Improvements in aeroplanes.

22258. October 20th. J. M. WRIGHT. Improvements in and relating to airships.

22307. October 21st. F. C. BARON and ORS. Improvements in aerial machines.

22308. October 21st. F. C. BARON and ORS. Improvements in aerial machines.

22384. October 22nd. F. C. BARON and ORS. Improvements in aerial machines.

22417. October 22nd. C. L. WELLS. Balloon ship.

22528. October 23rd. L. J. MAYER. Improvements in or relating to landing places for aerial vehicles, 22568. October 23rd. R. Edwards. Improvements in flying machine propellers.

22672. October 26th. W. M. Walters. Improvements in appliances for raising and moving bodies in the air.

22674. October 26th. J. de Beaumont and E. W. Coleman. New apparatus for propelling, steering, raising and lowering of airships, flying machines, and such like.

22789. October 27th. H. B. Webb. Toy model glider or aeroplane.

22809. October 27th. E. Perks. Improvements in or relating to flying machines.

22832. October 27th. E. W. Ridges. Appliance for sustaining or raising heavy bodies in, or moving heavy bodies through, the air.

22943. October 28th. K. L. W. Geest. Improvements in airships or flying machines.

23048. October 29th. H. F. Phillips. Improvements in or relating to flying machines.

23104. October 30th. J. L. Garsed. Improvements in aerial machines.

23129. October 30th. W. Hammont. Imments relating to aerial machines and the like.

23208. October 31st. F. W. T. Taylor. Aerial machine.

NOVEMBER.

23316. November 2nd. J. L. Garsed. Improvements in aerial machines.

23332. November 2nd. G. Fischer and T. Walti. Airship.

23347. November 2nd. A. A. Holle. Imments in aeroplanes.

23435. November 3rd. J I. Kay. Aerial multiform, multiplane and sections.

23595. November 4th. W. Friese-Greene. Improvements in and relating to airships, aeroplanes and the like.

23618. November 4th. S. Schutz. Propeller for flying machines.

23656. November 5th. A. W. Abbott. Elevating platform for aeroplanes and other purposes.

23798. November 6th. I. E. Mercer. Improvements in aerial machines.

23907. November 7th. O. Ricaldoni and G. A. Crocco. Improvements in and relating to dirigible aerostat airships.

24076. November 10th. W. Wright and O. Wright. Improvements in or connected with flying machines.

24077. November 10th. W. Wright and O Wright. Improvements in or connected with flying machines.

24126. November 10th. G. J. G. Jensen Apparatus for controlling airships and flying machines.

24148. November 11th. P. F. Degn. Improvements in flying machines.

24202. November 11th. F. A. D. Simori. Improvements in or relating to dirigible aerial machines.

24344. November 12th. W. H. Fauber. Improvements in aeroplanes.

24441. November 13th. J. W. Cloud. Improvements relating to apparatus for aerial navigation.

24460. November 13th. H. V. Rose. Propeller to produce a method of flight when adapted to flying devices or machines, balloons, or airships, and to propel any body or object on or under water.

24557. November 16th. J. Keegon. Propulsion of steamships, airships, or the like, by a periodical variation relative to the propeller or in the position of its centre of gravity.

24617. November 16th. G. A. Peache. Improvements in flying machines.

24650. November 17th. H. Gough-Turner. Improvements in or relating to aerial machines.

24682. November 17th. J. L. Garsed. Improvements in aeroplanes, wings, or gliders, and in the means or apraratus for operating the same.

24731. November 17th. C. La Fontaine. Improvements in or relating to flying machines and dirigible balloons.

24890. November 19th. W. McMaster. Method of combining the propelling and balancing of airships and aeroplanes in one movement.

25166. November 23rd. E. J. Lester and W. G. Best. Improvements in and relating to airships and aeroplanes.

24928. November 19th. A. Facquin. Improvements in aerial machines.

25102. November 21st. J. B. W. Maunder. Improvements in and connected with airships.

25315. November 24th. W. P. Thompson. Improvements in flying machines.

25490. November 26th. H. H. Duden. Improvements in propellers for aerial navigation.

25581. November 27th. A. W. Abbott. Improvements in aeroplanes.

25672. November 28th. H. H. Duden. Improvements in Steering for aerial navigation.

25774. November 30th. H H. Duden. Improvements in methods for propulsion for aerial navigation.

DECEMBER.

26066. December 3rd. J. Bonham. Rotary navigable flying machine.

26214. December 4th. E. Waddington. Propelling arrangement combined with an aeroplane to lift a vessel when in motion from the surface of water.

26289. December 4th. C. Coma. Improvements in and relating to screw propellers for marine or aerial navigation.

26381. December 5th. R. Lenhmann and J. Heinze. Improved aerial projectile capable of use as a toy also for purposes of warfare,